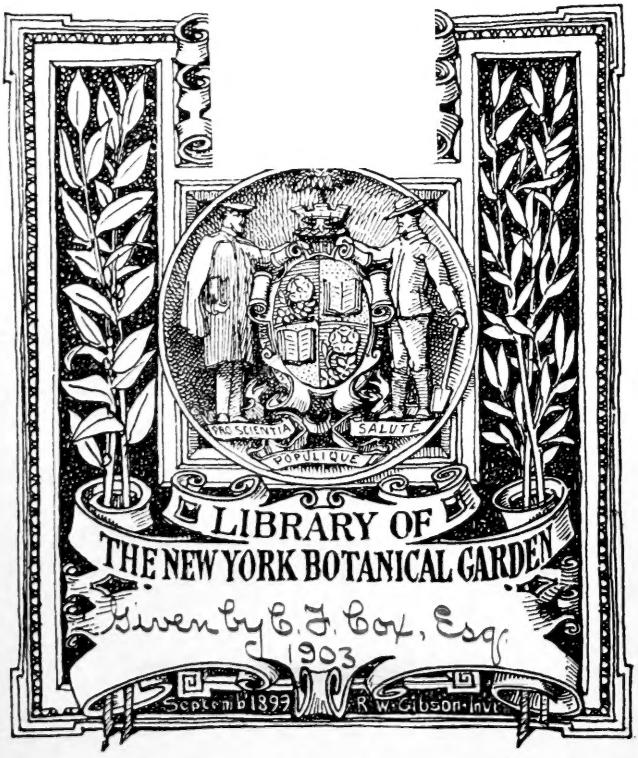
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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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

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

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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AND

J. ARTHUR THOMSON, M.A., *Lecturer on Zoology in the School of Medicine, Edinburgh,*

FELLOWS OF THE SOCIETY.

FOR THE YEAR

1887.

Part 1.

PUBLISHED FOR THE SOCIETY BY

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PREFACE.

This Journal has now completed the tenth year of its publication, since it was launched on the extended basis which was inaugurated after its first year, when it formed a volume of 402 pages only.

Throughout this period I have had no reason to complain of any want of appreciation, but on the contrary have to acknowledge a veritable load of congratulations of a very demonstrative character, not only from microscopists but from biologists generally who have recognized the value of a publication—the only one in the English language—which enables its readers to make themselves acquainted without delay with the contents of the enormously scattered literature of Biology and Microscopy throughout the world. It is the fact of this consensus of opinion that leads me to add this Preface to the present volume, as the approbation that has been showered on the Journal has not fully reached those who are most worthy of it.

In the case of a battle, it is perhaps necessary that it should pass as the victory of the particular general in command, however much it may have been due to the skilful arrangements of the commanders of divisions or to the general valour of the rank and file, but we are not trammelled by any such rules in the case of this Journal, and it is proper therefore to call attention to the extent to which its success is due to my Co-editors.

In the departments of Botany and Zoology, Mr. A. W. Bennett and Prof. F. Jeffrey Bell have now for nearly ten years analysed the various papers which have been recorded in the Summary of Current Researches. No one who has not actually undertaken it can have any idea of the extent of the labour which this involves. My own preliminary work in advance of the actual analyses has required a certain amount of resolution to face week after week, but this labour has been very small in comparison with that undertaken by Mr. Bennett and Prof. Bell, who have had to read through the whole of the papers and then to produce those analyses which have appeared in number after number. Moreover, the length of the notes is practically in inverse proportion to the difficulty of writing them. It is easy to produce an extended abstract;

the difficulty is to condense the leading ideas of the author into a brief compass, so that any one who desires to know its scope, and to determine whether it is desirable to refer to the original paper, can have before him the necessary guidance. All this has been done by Mr. Bennett and Prof. Bell, with an amount of skill and with a degree of regularity which at the outset I should hardly have believed possible. What is still more remarkable, is the punctuality which has been observed throughout. In no single instance has the MS. been received after the appointed time; in most cases it has been in advance of time. A striking testimony to what has thus been accomplished is to be found in the view of an eminent biologist, who, in the earlier days of the Journal expressed the opinion that the Summary must necessarily in a short time "run thin": the same biologist last year spontaneously declared that "the Journal got better and better." I claim therefore for Mr. Bennett and Prof. Bell that botanists and zoologists owe them a large debt of gratitude for the good work they have done with so much self-sacrificing perseverance.

The Microscopical division of the Journal is in like manner greatly indebted to Mr. J. Mayall, jun., for a large amount of assistance which for the same length of time he has rendered in this department; assistance of such a character that without it it would have been impossible to produce the varied assortment of matter which has kept microscopists so fully informed as to all that is novel, interesting, or curious in the various sections of the subject.

I have left unnoticed the services of Mr. J. Arthur Thomson, who has recently undertaken, with no little success, a part of the Zoology, and of Dr. Hebb, who has practically had complete charge of the Technique section, with what result the pages of the last two volumes of the Journal abundantly show. This omission arises from the fact that I have been dealing not only with the quality of the services rendered by the three senior Co-editors, but also with the remarkable length of time over which those services have extended, and in which respect they at present stand alone.

It is to be hoped that the increased circulation of the Journal outside the Society may allow of some adequate return in a substantial form being made to the Co-editors, and, meantime, I tender to them not merely my own thanks but those of the Fellows of the Society at large, and I hope and believe those of a still wider circle of biologists and microscopists also.

FRANK CRISP.

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

a. Embryology.

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

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(4) Staining and Injecting.

(5) Mounting, including Slides, Preservative Fluids, &c.

(6) Miscellaneous.

PROCEEDINGS OF THE SOCIETY—

e Index No. is delayed from exceptional and unavoidable causes, but will be issued shortly.

1887. Part 1. FEBRUARY. { To Non-Fellows, Price 5s.

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ZOOLOGY.

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α. Embryology.

β. Histology.

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B. INVERTEBRATA.

BOTANY.

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(1) Stands.

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(3) Illuminating Apparatus.

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I.—APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Pe tra Po ($\frac{1}{a}$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·6
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·6
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·6
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·6
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·6
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·6
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·6
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·6
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·6
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·6
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·7
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·7
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·7
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·7
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·7
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·7
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·7
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·7
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·7
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·7
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·7
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·7
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·7
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·7
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·7
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·7
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·7
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·8
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·8
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·8
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·8
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·8
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·8
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·8
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·8
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·8
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·8
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·8
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·8
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·8
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·8
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·9
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·9
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·9
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·9
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·9
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·9
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·9
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·9
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·9
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·9
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·9
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·0
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·0
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·0
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·0
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·0
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·0
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·0
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·0
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·0
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·0
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·1
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·1
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·1

APERTURE TABLE—*continued.*

Numerical Aperture. ($n u = a$.)	Corresponding Angle ($2u$) for *Air* ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	Limit of Resolving Power, in Lines to an Inch. White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$, near Line *h*.)	Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·941
·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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105	1½ inch	23	2 10 0	30	48	90	120	150
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107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4 10 0	250	400	750	1000	1250
113	$\frac{1}{8}$ inch	130	5 0 0	400	640	1200	1600	2000
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154	¼ inch	80	1 5 0	170	220	415
155	$\frac{1}{0}$ inch	110	2 5 0	250	330	630
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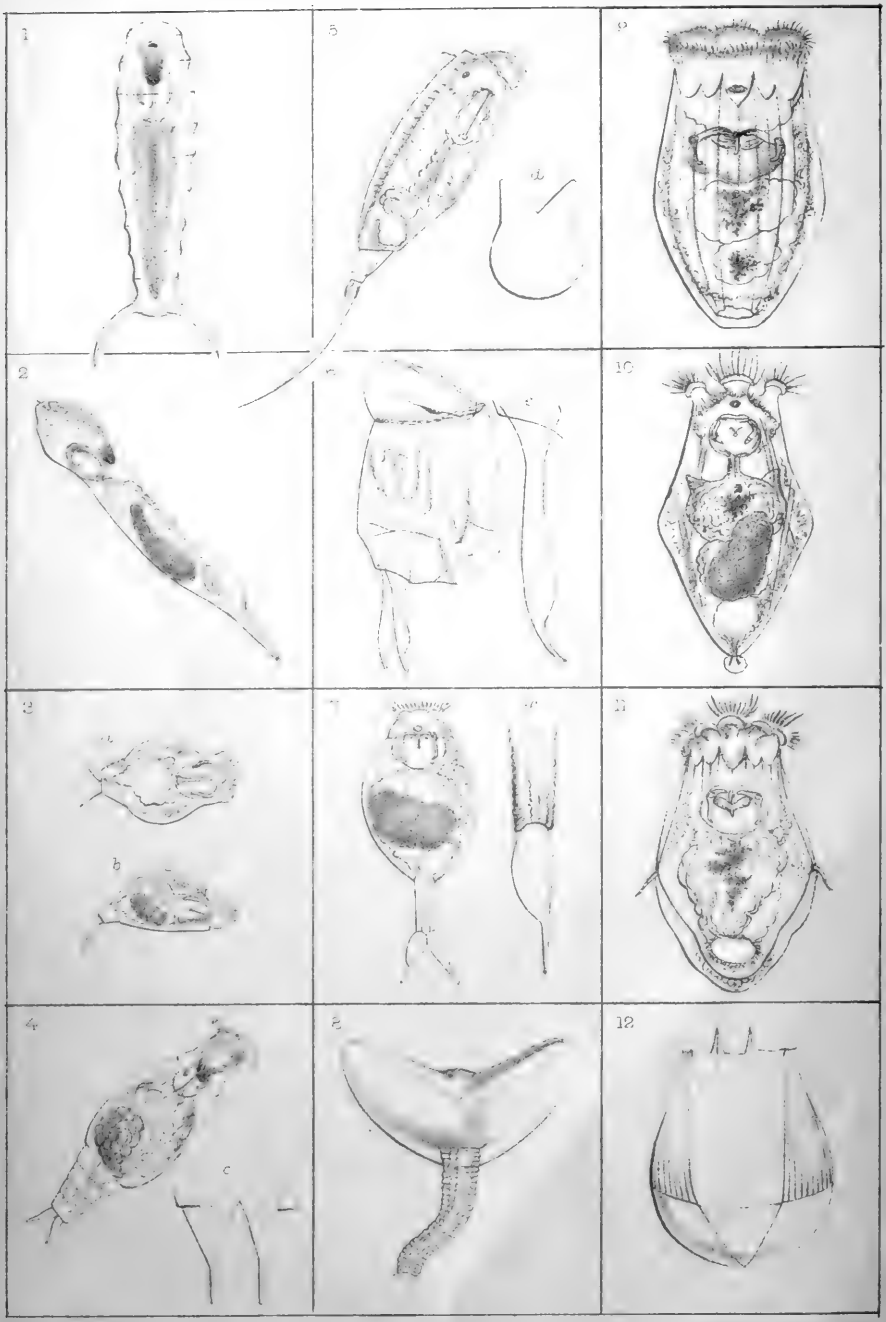

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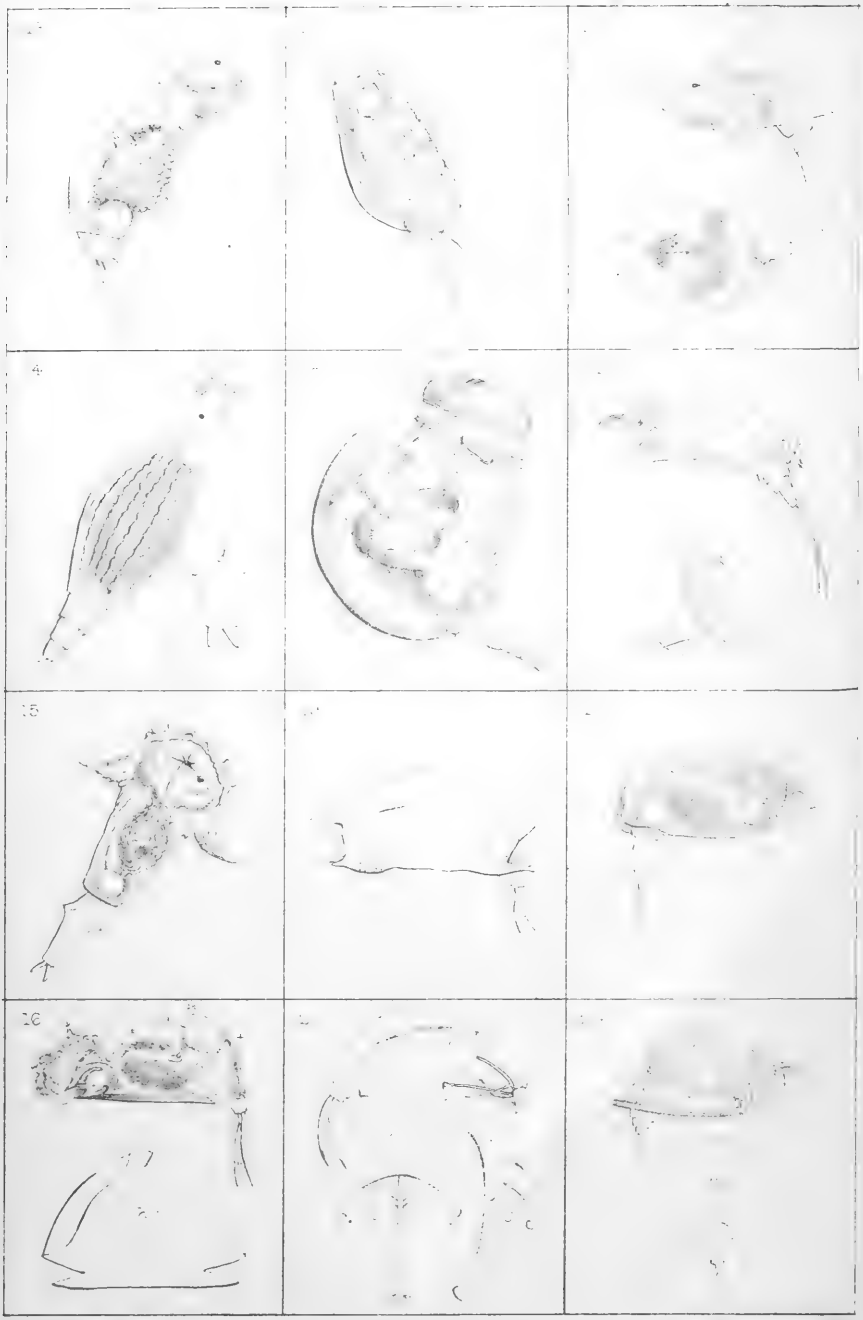
New Rotifera.



New Rentera

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1887.

TRANSACTIONS OF THE SOCIETY.

I.—*Twenty-four New Species of Rotifera.*

By P. H. Gosse, F.R.S., Hon. F.R.M.S., &c.

(*Read 8th December*, 1886.)

Plates I. and II.

The following species of Rotifera were discovered either too late to be included in Dr. Hudson's work, or since that work was published. They are described with brevity; but, I hope, with precision sufficient for identification and differentiation.

1. *Taphrocampa selenura.* Body thick towards the head, tapering towards the foot; marked with strong articulations like *T. annulosa*; brain opaque, with a distinct red eye on its inner side; caudal fork a wide crescent; trophi as in *Notommata aurita.* Length 1/100 in. Lacustrine.

Since the note in H. and G. Rotif., i. 17, I have made repeated

EXPLANATION OF PLATES I. and II.

Fig. 1.—*Taphrocampa selenura;* dorsal.
„ 2.—*Diglena* (?) *silpha;* lateral.
„ 3.—*Notommata ovulum; a*, dorsal; *b*, lateral.
„ 4.—*Furcularia melandocus;* dorsal; *c*, toes, enlarged.
„ 5.—*Mastigocerca bicristata;* lateral; *d*, ideal section.
„ 6.—*Diaschiza* (?) *cupha;* lateral; *e*, one toe, enlarged.
„ 7.—*Mytilia Teresa;* dorsal; *f*, one toe, enlarged.
„ 8.—*Pterodina reflexa;* posterior.
„ 9.—*Notholca jugosa;* dorsal.
„ 10.— „ *rhomboidea;* dorsal.
„ 11.— „ *spinifera;* dorsal.
„ 12.— „ *polygona;* dorsal.
„ 13.—*Furcularia lophyra;* lateral.
„ 14.—*Callidina pigra;* dorsal; *g*, spurs, enlarged.
„ 15.—*Synchæta longipes;* dorsal.
„ 16.—*Euchlanis oropha;* lateral; *h*, transverse sections, the outer at *, the inner at †, of upper figure.
„ 17.—*Distyla striata;* dorsal.
„ 18.—*Asplanchna eupoda;* lateral.
„ 19.—*Salpina marina* (lorica); lateral.
„ 20.—*Diaschiza* (?) *rhamphigera;* lateral; *i*, trophi, dorsal; *j*, lateral.
„ 21.—*Colurus Dumnonius;* lateral; *k*, ventral.
„ 22.— „ *dicentrus;* lateral; *l*, termination of body.
„ 23.— „ *grallator;* lateral.
„ 24.—*Monura micromela;* lateral; *m*, posterior.

examinations of this form, which, I am now convinced, has specific value. The crescent behind is glassy clear throughout, continuous with the body, not articulated; its form is that of the new moon when first visible. Cf. *Balatro clavus* Clap. (Plate I. fig. 1.)

2. *Diglena* (?) *silpha.* Body sub-cylindric, stouter at the head, abruptly lessened behind; brain saccate, long, opaque at the end; toes minute, conical. Length 1/100 in. Lacustrine.

The whole animal is very soft and plump, not wrinkled, even in retraction. A well-marked, soft, decurved proboscis is on the front: no eye is visible. The sudden attenuation of the body to a slender cylinder, one-fourth of the whole length, is remarkable; this terminates in two or three soft lobes, below which are two very minute toes, with no appreciable foot intervening; for the rectum can be traced to a cloaca, just above the toes. Fuller examination is needed: I have seen but a single example, sent from the middle of Ireland; and the trophi were not satisfactorily defined. (Fig. 2.) Cf. *Notommata forcipata,* lat. aspect.

3. *Notommata ovulum.* Very small; body globose, plump; dorsum gibbous; venter flat: brain clear; eye wanting: foot short; toes rather long, acute, decurved. Length 1/370 in. Lacustrine.

This attractive little form has so much resemblance to *N. lacinulata,* that I had doubted whether it is not a *var.* of that species. There are, however, divergences, important, if minute. It is very much rounder in all aspects; the toes are longer, uniformly diminishing to acute points, and decidedly decurved: no trace of eye could be discerned. It swims rapidly, but evenly; does not *spring,* and does not *twitch*;—both which actions are so characteristic of *lacinulata.* Auricles (?) are occasionally pushed out. The front projects in a tubercle, halfway between which and the auricle on each side is a stiff seta. I have examined three specimens, two from Woolston, and one from Dundee. (Fig. 3.)

4. *Furcularia melandocus.* Body swollen, obtusely narrowed in front, tapering behind: brain saccate, opaque at the extremity: foot large; toes conical, each terminating in a soft, slender point, much produced. Length 1/130 in. Lacustrine.

Of excessively versatile outline, rapidly lengthening and shortening every instant. The front is apparently hard, with a sharp edge, below which is a broad, sub-prone, ciliate face. An ample brain-sac,—its terminal portion filled with chalky deposit, usually intensely black by transmitted light, but in some examples much diluted,—looks like a bottle of ink swaying to and fro in the animal's contortions. The prolonged finger-like tips of the toes (*c*) have a strong adhesive power, dependent on a pair of great mucus-glands. A minute frontal eye is not *quite* certain. Several examples have occurred in water from Woolston. (Fig. 4.)

5. *Mastigocerca bicristata.* Two equal sub-parallel carinæ, running nearly the whole length of the dorsum. Length 1/50 in., of which the toe is nearly half. Lacustrine.

Discovered near Dundee, by Mr. Hood, who sent me from time to time many examples. It has a general likeness to *M. carinata,* but is much larger. The double carina confirms the conjecture that the asymmetry of that and other species is due to unequal development.

The carinæ are thick at their base, and sharp at their edge, so that the furrow is sharp at the bottom, and has sloping sides. (Fig. 5: *d*, ideal section.)

6. *Diaschiza* (?) *cupha*. Much compressed; dorsum squarely gibbous: foot short, scarcely protruding; toes long, blade-shaped, slightly recurved, with claws abruptly shouldered. Length 1/124 in. Lacustrine.

This hunch-backed form needs fuller examination. I describe it from a single example, just dead, but not decomposed, in water sent from Birmingham. The depth, compared with the width, of the animal is remarkable. The trophi were very long, but ill-defined: in the occiput is a short brain, carrying a flat, lens-shaped red eye on its inner surface. The peculiar shape of the toes is shown at *e*. I affix a mark of doubt to the *generic* position, because I could not be *quite* sure of the dorsal cleft. (Fig. 6.)

7. *Mytilia Teresa*. Body truly oval: toes together wider than foot; each toe large, long, ovate, abruptly produced to a long, slender, acute point. Length 1/200 in. Marine.

This very pleasing species I have found in some abundance, in water dipped for me out of tide-pools in various parts of Torbay by my little granddaughter, with whose name I honour it. It has a very distinct red eye in the occiput. The large bulbous toes are peculiar, of which one is shown laterally at *f*. It is a sprightly creature, playing actively among confervoid algæ, often pivoting on its toes, like a *Cathypna*, jerking and bowing: it is less locomotive than *M. Tavina*. (Fig. 7.)

8. *Pterodina reflexa*. Lorica elliptical in outline, the two longitudinal halves bent upward and backward, at a considerable angle; the dorsal surface being evenly furrowed, the ventral rounded. Length of lorica 1/220 in. Lacustrine.

The angular character is not noticed on a dorsal view, but becomes conspicuous in the act of turning. *P. valvata* bends its leaves *downward*, on hinges, at will. *P. reflexa* bends its halves *upward*, on a medial line which is not hinged, but permanent. It is somewhat like a butterfly, sitting, with half-opened wings, on a flower in an autumn noon. The internal structure is normal. I have found it abundant in water from Smallheath, Birmingham. (Fig. 8.)

9. *Notholca jugosa*. Lorica ovato-rhomboid, highly elevated, broadly truncate before, narrowly behind: ridges and furrows strongly marked, ending before they reach the hind margin. Length 1/190 to 1/130 in. Marine.

This, of all the *Notholcæ*, seems to come the nearest to Ehrenberg's figure of *Anuræa striata*; of which he says, it is marine at Copenhagen, associating with *Pter. clypeata* and *Brach. Mülleri*, species with which *jugosa* is commonly found in the tide-pools of the Firth of Tay and of the Devon coast. (Fig. 9.)

10. *Notholca rhomboidea*. Lorica rhomboidal, with the lateral angles rounded, the front produced and truncate; dorsal and ventral plates separated behind by a short cleft. Length 1/160 to 1/145 in. Marine.

The ridges, in this species, can with difficulty be discerned, especially as the rotating head is habitually protruded, which the creature does not retract for the shock of any tap or shake of the instrument that I

can give. There is a long wrinkled œsophagus, a great saccate stomach, a distinct intestine, with the cloaca at the very extremity of the lorica: the branchial bands are distinct, but no contractile vesicle. It is not uncommon, with the preceding. (Fig. 10.)

11. *Notholca spinifera.* Lorica broadly sub-rhomboidal; the dorsal plate often less than the ventral, and separated by a wide and deep cleft: at each angle of junction is seated a short spine, so hinged as to be concealed within the cleft, or widely projected, at will. Length of lorica 1/220 to 1/100 in. Marine.

An interesting and attractive species. The whole interior is often richly coloured, especially the enormous stomach. An ample contractile vesicle is present. The hind outline in some examples is evenly rounded; in others an inangulation marks both plates. Ehrenberg's figure of *Anur. biremis* may be compared with this; but it differs in important details; and his text gives no help. I receive this also from the Tay tide-pools. (Fig. 11.)

12. *Notholca polygona.* Lorica roundly pear-shaped, truncate in front; the central pair of the occipital spines stout, the other two pairs almost obsolete: ventral plate forming a square box, with sloping, many-angled sides. Length 1/160 in. Lacustrine.

A remarkable form. The dorsal plate is a half-oval, the ventral nearly flat. The latter is very peculiar: a kind of sub-cubic box, open at the summit, runs down to about three-fourths' length, and then proceeds, in pyramidal form, to a point at bottom; and this appears to contain the viscera. Each side is covered-in by a plate of two planes, but appears to be empty. On those parts of the arched dorsal plate which answer to these empty lateral chambers, run down very delicate flutings, while the broad medial part is quite clear and smooth. All the angles are distinct. The only example seen was dead, but showed a crimson eye and a normal mastax. From Kingswood Pool, near Birmingham. (Fig. 12.)

13. *Furcularia lophyra.* Body fusiform: head separated by a constriction; back sharply ridged; toes broad at base, tapering at mid-length to long-drawn fine points. Length 1/290 to 1/260 in. Lacustrine.

Somewhat near to *F. gracilis*, but the above characters, which are constant in a great number of examples, sufficiently distinguish it. The body, sub-cylindric at first, swells more or less behind the middle, where the dorsum rises to a sharp edge, *not a carina.* The head is large, always distinct, with a brilliant eye at the very front, and a prone ciliate face. The trophi are those of *gracilis*, very large, often extruded. A thick short foot bears two great toes, often widely expanded, one-fourth of the whole length; each is a glassy rod, of thick base, which tapers somewhat abruptly near the middle to a long point of great tenuity. (Plate II. fig. 13.)

14. *Callidina pigra.* Body fusiform, fluted, not collared; column having a decurved acute hook; spurs minute; viscera rufous. Length (extended as in fig.) 1/90 in. Lacustrine.

I have seen two examples, both of which had the extremities colourless, but the middle tinged of a delicate sherry-brown, the viscera

somewhat deeper in hue; while in one was an immense egg, of a coffee-brown, almost opaque, whose appearance suggested the probability that the species is strictly oviparous. The acute hooked proboscis is very conspicuous. The corona, scarcely divided, is not wider than the neck at the antenna, and this neck is not swollen into a collar. The penultimate spurs are very minute cones, whose bases are not separated by an interspace (fig. 14, *g*). The whole central body is indented with longitudinal furrows. The mallei are destitute of visible teeth. (Fig. 14.)

The animal is remarkably sluggish, rarely swimming, but turning its head slowly and aimlessly from side to side. It has occurred in Woolston Pond.

15. *Synchæta longipes.* In front much like *S. pectinata*, but with the foot distinct, separated, long, furnished with two small toes. Length 1/173 in. Lacustrine.

The well-marked foot, having a rhomboid outline, common to all the eight or ten specimens that I examined, appeared to me sufficient, when combined with its small dimensions, to distinguish this species from *S. pectinata*, with which else it has much in common. The broad head bears four frontal warts and two setæ. It has occurred in some profusion in fresh water near Dundee. (Fig. 15.)

16. *Euchlanis oropha.* Lorica roof-shaped with sloping sides, but not rising to a ridge, yet cleft for a short distance behind, between two descending extremities. Ventral plate flat, thin, much smaller in its whole outline than the carapace: foot with a single seta or none; toes thin, blade-shaped. Length, total, 1/75 in. Lacustrine.

This is a noble species, and not uncommon. The posterior fourth of the ovate lorica seems as if pinched-in, and the dorsal edge *of this portion* becomes a low double carina. In fig. 16, *h*, the inner outline is that of this portion (posterior to † in the upper figure), the outer outline represents a transverse section at * in the upper figure. (Fig. 16.)

17. *Distyla striata.* Lorica as in *D. Gissensis*, but covered with longitudinal sulci; the front margin projecting in two lateral points (which, however, are lost in the protrusion of the head, by the evolution of flexible membrane): toes slender, straight, more than half as long as lorica, pointed, not shouldered. Length 1/130 in. Lacustrine.

The lateral infold is narrow and nearly closed. The dorsal sulci are about eight in number, slender and superficial: foot a long large bulb, not divisible into joints; toes long, nearly straight, rods. The dorsal surface is corrugated, besides the sulci; there is a minute eye, difficult of detection. Two examples occurred in water sent me by Dr. F. Collins from the pool at Sandhurst Military College. (Fig. 17.)

18. *Asplanchna eupoda.* Body globose, with a stout foot, retractile at will: rami of incus long, each armed on its inner edge with four widely-severed teeth. Length, moderately extended, 1/52 in., width 1/118 in. Lacustrine.

The most remarkable feature is the foot, which is, proportionally, much larger than in *A. myrmeleo*. The pincer-like rami are those of a normal *Asplanchna*, having a close resemblance to those of *A. priodonta*, save that their inner edges are not cut into saw-teeth, but beset with three distant spinous teeth, while each curved point is double. I have

examined eight or ten examples, all from the canal, Smallheath, Birmingham. (Fig. 18.)

19. *Salpina marina.* Occipital spines two, procurved; pectoral two, short; lumbar spine short, deep; alvines stout, separated from the lumbar by an angular sulcus. Length of lorica, from points to points, 1/136 in. Marine.

This large species was taken in a tide-pool in the Firth of Tay; the first *Salpina* found in the sea. Its anterior armature is that of *S. mucronata*, but the posterior is peculiar, in that the alvines are stout, nearly straight spines, and that the sinus which divides each from the lumbar point is not rounded, but makes two sides of a rhomboid, with definite angles. The specimen was dead when I found it. (Fig. 19.)

20. *Diaschiza (?) rhamphigera.* Lorica elliptical in outline, viewed dorsally; highly gibbous, viewed laterally; venter flat: toes stout, long, decurved: trophi projecting in form of a bird's beak. Length 1/173 in. Lacustrine.

The front terminates in an acute hooked beak, which is found to be the extremity of the trophi, and apparently of the incus protruded. The whole manducatory apparatus is of unusual dimensions, especially the fulcrum of the incus. (Fig. 20, *i*, represents the trophi seen dorsally; *j*, laterally.) I have not distinctly seen the dorsal cleft; but the line which passes along the back, at some distance from the edge, I presume to indicate the bottom of such a cleft; if it is not the base of a high carina. Two examples occurred together in water from one of my window tanks. (Fig. 20.)

21. *Colurus Dumnonius.* Lorica in dorsal aspect a very broad oval, produced behind into two rather short points, separated by a wide but shallow sinus: the ventral line deepens in the middle; the ventral cleft extends around the front to the occiput: foot robust, with two moderately stout, separable toes. Length 1/260 in. Marine.

Three examples I have seen at different times among fine conferva, much studded with *Licmophoreæ*, from tide-pools at Paignton, near Torquay. One of these had the sides much more parallel than the others. A large pale red eye is conspicuous. All had the habit of pivoting on the toe-tips, jerking and posturing. (Fig. 21.)

22. *Colurus dicentrus.* Lorica ovato-fusiform: body ending behind in a minute tail of two hooks adnate at their base: foot stout; toes long, very slender, more or less decurved throughout. Length 1/185 in. Marine.

I have examined nearly a score of individuals, and am satisfied that this is a true species, in which the peculiar termination of the body (shown enlarged in fig. 22, *l*) is constant, thus differing from *C. amblytelus* and *C. grallator*. The tail-points resemble rose-prickles. The appressed toes seem a single slender spine, but are often thrown apart. Two red eyes are distinct. It is not rare in the Tay tide-pools. (Fig. 22.)

23. *Colurus grallator.* Lorica much compressed; lateral outline ovate, sub-square behind, without points: toes half as long as lorica, very slender, straight, readily separated: ventral cleft slightly narrowed in the middle. Length 1/250 in. Marine.

Nearly related to the preceding; but the outline, viewed dorsally, is longer and narrower; there is no protrusion of the body behind the lorica; and the toes are quite straight. The frontal hook is unusually narrow. I have not been sure of an eye. A dozen examples have occurred from the Tay tide-pools. (Fig. 23.)

24. *Monura micromela.* Lorica in dorsal aspect broadly ovate, produced behind into slightly projecting points, separated by a shallow rounded sinus: in lateral aspect the quadrant of an oval: foot small; toe single, of uniform excessive tenuity. Length 1/230 in. Lacustrine.

I have had, for thirty-six years, drawings of a species which I had marked (with "?"), as *Monura dulcis.* Very recently, in water from Slough, what seems the same form, now figured, has occurred, and that repeatedly. The excessive tenuity of the toe, which seems indivisible, is the most striking feature; and then the round sinus between the lorica-points (*m*). No eye is visible. The general figure is that of *Col. bicuspidatus.* (Fig. 24.)

II.—*Fresh-water Algæ (including Chlorophyllaceous Protophyta) of North Cornwall; with descriptions of six new species.*

By Alfred W. Bennett, F.R.M.S., F.L.S., Lecturer on Botany at St. Thomas's Hospital.

(*Read 12th January*, 1887.)

Plates III. and IV.

So little is known accurately of the geographical distribution of any of our fresh-water algæ, that it seems to me a complete record may not be without value of all the species observed during a six weeks' stay in North Cornwall, in August and the early part of September 1886. The localities from which gatherings were made were entirely in the northern part of the county, from Boscastle to Newquay, a distance of about thirty miles, and mostly within a short distance of the sea. This is chiefly a limestone country, no granitic or other volcanic districts having been visited. It is characterized by the entire absence of peat-bogs over a large portion of the area; but the few examined, at Mawgan, Roche, and St. Denis, were rich in desmids and other organisms.

On comparing this list with that made in the previous year in the English Lake Country, they are seen to differ considerably.* It is not, however, in any way suggested that either list approaches completeness, or that the species which occur in one only of the lists may not ultimately be found in both districts. In order to facilitate the comparison I have prefixed an * in the present list to those species not included in that for the Lake District. Some general comparisons between the two may, however, be interesting.

EXPLANATION OF PLATES III. and IV.

Fig. 1.—Apiocystis Brauniana Näg. × 200.
„ 2.—Hydrianum heteromorphum Reinsch × 400.
„ 3.—Aphanothece microscopica Näg. × 100.
„ 4.—Oscillaria princeps Vauch. × 200.
„ 5.—Stigonema minutum Hass. ? (outline only) × 100.
„ 6, 7. „ „ portions of primary filament × 200.
„ 8. „ „ portion of primary filament, showing attachment of branch, × 200.
„ 9, 10 „ „ portions of branch, × 200.
„ 11.—Pediastrum integrum Näg., young cœnobium × 300.
„ 12. „ „ older cœnobium × 300.
„ 13. „ „ portion of ditto, showing possible resting-cell *a*, × 400.
„ 14.—Cœlastrum cubicum Näg. × 600.
„ 15.—Selenastrum bifidum Benn. × 400.
„ 16. „ „ „ single cell × 600.
„ 17.—Docidium granulatum Benn. × 400.
„ 18.—Euastrum oblongum Grev. *var.* integrum Benn. × 200.
„ 19.— „ crassum Bréb. *var.* cornubiense Benn. × 200.
„ 20.— „ crenulatum Benn., front view × 600.
„ 21. „ „ „ end view × 600.
„ 22.—Cosmarium sphericum Benn. × 300.
„ 23. „ discretum Benn. × 400.
„ 24.—Staurastrum cornubiense Benn. × 800.

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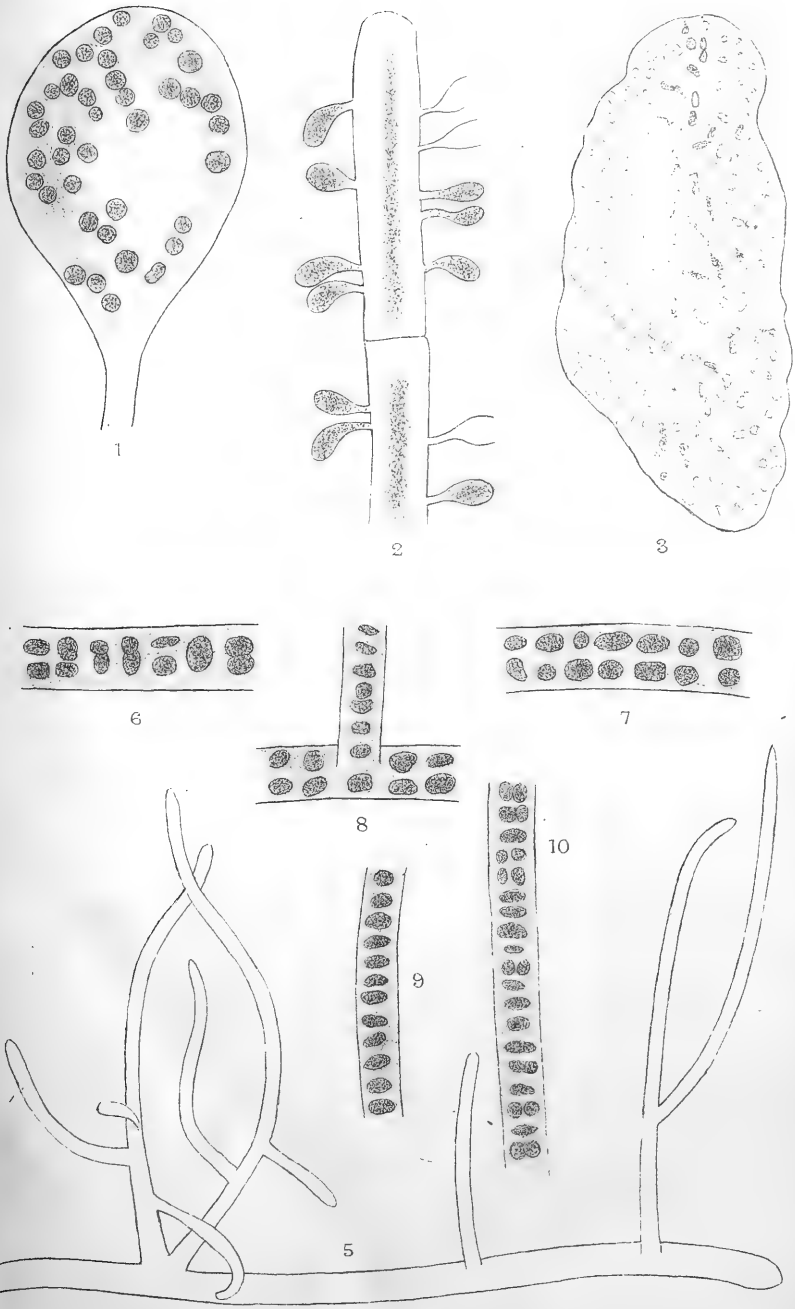
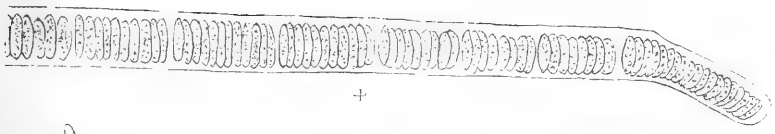
* This Journal, 1886, pp. 1–15.



A.W.B. del. ad nat.

West, Newman & Co. lith.

Algæ &c. of North Cornwall.



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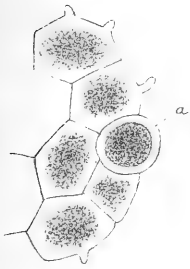

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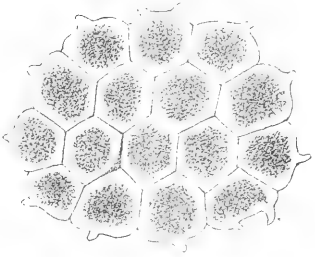

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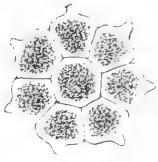

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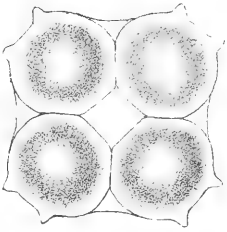

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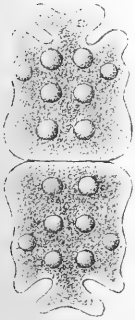

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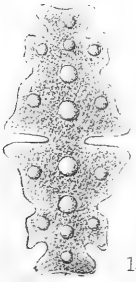

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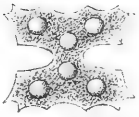

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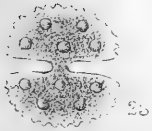

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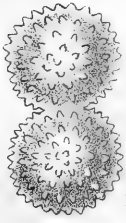

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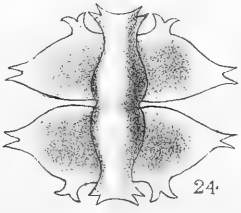

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A.W.B. del. ad nat.

West, Newman & Co. lith.

Algæ &c. of North Cornwall

The occurrence of five out of the seven British fresh-water Ulvaceæ in the Cornwall list, all absent from that for Westmoreland, is probably due to the proximity of the sea. Of greater interest is the observation of several species of microscopic Protophyta which may be included in the family Characiaceæ, using the term in its larger sense. This, I have little doubt, is due to the lower latitude; and it is probable that further search, and a better acquaintance with this class, might lead to the discovery of a number of new and interesting forms. Among the beautiful Pediastreæ and Sorastreæ I have had the good fortune to meet with four very interesting species which have not hitherto been observed in Britain, one of them new to science, as also a very striking *Oscillaria*. The greater number of the Desmidieæ were gathered in pools on the few peat-bogs above referred to. Comparing them with my experience of the Lake District, I must note the comparative absence of the larger species, especially *Micrasterias*, *Xanthidium*, *Holocystis*, the larger *Euastra*, and the whole of the filamentous forms, though this applies more to the comparative paucity of individuals than to a reduction in the number of species. On the other hand, the larger *Cosmaria* and *Closteria* were quite as frequent, while the genera *Penium* and *Docidium* were more abundant, at least as far as the number of individuals is concerned. I was also struck with the large number of extremely minute forms belonging to the genera *Cosmarium*, *Staurastrum*, and *Arthrodesmus*, some of which, I cannot doubt, represented species hitherto undescribed.†

PROTOPHYTA.

Protococcaceæ (including Palmellaceæ).

Eremosphæra viridis dBy.
Glœocystis vesiculosa Näg.
* „ ampla Ktz.
Botryococcus Braunii Ktz.
Rhaphidium falcatum Cooke.
* „ aciculare Br. Bog pool, Mawgan.
Protococcus viridis Ag.
*Chlorococcum frustulosum Carm. Boscastle.
„ gigas Grün.
*Polyedrium tetrahedricum Näg. Bog pool, Mawgan.
Scenedesmus acutus Mey.
„ quadricauda Bréb.
* „ obtusus Mey.

Not unfrequent in bog pools. I do not find the character by any means constant that the cells are always "remote from one another"; their contact is frequently as close as in *S. acutus*.

Characiaceæ.

*Apiocystis Brauniana Näg. Fig. 1.

This interesting organism was seen only once, attached to *Zygnema insigne* in a mill-dam in the valley of the Gannel. It appears to have

† The names of new species are again printed in SMALL CAPITALS, those of species new to Britain in *italics*.

been detected in this country only once before, by Henfrey, as long ago as 1856, at Wimbledon. My observations agree nearly with the descriptions of Nägeli and Cooke, but I was not fortunate in having the mode of reproduction under view The "frond" was irregularly pear-shaped, with well-defined outline, 275 μ long by 165 μ broad (including stalk), the stalk 62·5 μ long by 25 μ broad. The "gonidia" or green pseudo-cells appeared to be arranged in a parietal layer, some of them in pairs as if they had undergone recent division, moderately crowded towards the apex of the "frond," fewer towards the base, entirely wanting in the stalk. They were bright green, round or slightly oval, about 17 μ in diameter or less.

*Dictyosphærium Ehrenbergianum Näg.

Bog pool, Mawgan. In the specimens observed the reniform pseudo-cells were united together in pairs or threes by a slender thread; the whole colony was moving rapidly through the water, but was not inclosed in hyaline gelatin.

In the same pool was observed what is probably an undescribed species of the same genus; the cells much smaller and spherical, and united together irregularly in bunches.

*Hydrianum heteromorphum Reinsch. Fig. 2.

Attached to a *Mesocarpus* in a bog pool, Mawgan. Cells about 19 μ long by 10 μ broad, observed both closed and open, filled with a light brown endochrome.

CHROOCOCCACEÆ.

Chroococcus turgidus Näg.
*Glœocapsa polydermatica Ktz. On wet rocks, Boscastle.
Aphanocapsa virescens Rabh.
Microcystis marginata Kirchn.
*Cœlosphærium Kützingianum Näg.

Very common in bog pools. The "frond" may be nearly spherical or 2–3-lobed, always studded with pale blue-green projections. When 2-lobed, and the lobes nearly equal in size, it might readily, but for its blueish-green colour, be mistaken for a *Cosmarium*.

Merismopedia glauca Näg.
**Aphanothece microscopica* Näg. (Gatt. Einzell. Algen, p. 59, t. i. H. f. 1). Fig. 3.

Not uncommon in bog pools. Thallus irregularly oval, outline lobed or sinuous, about 650 μ long by 325 μ broad, perfectly colourless and hyaline. "Gonidia" or pseudo-cells narrowly elliptical, 25–40 μ long, 4–5 times as long as broad, somewhat pointed at both ends and usually divided or constricted in the middle, sparingly and nearly uniformly scattered through the thallus. Contents of pseudo-cells very pale blue-green. Differs from both the species described by Cooke as British in the thallus being colourless instead of blue-green, as well as in other points. First described by Nägeli from Zurich; Rabenhorst speaks of it as abundant in Germany.

Oscillariaceæ.

Oscillaria tenuis Ag.
* „ tenerrima Ktz. Bog pool, Roche.
* „ muscorum Carm. Bog pool, St. Denis.
**Oscillaria princeps* Vauch. Fig. 4.

Filaments free-swimming, quite solitary, 30–38 μ broad without the sheath, about 44 μ including the sheath, 20–40 times as long as broad. Invested in a very thin mucous sheath, fitting closely to the filament, and sometimes projecting slightly beyond it where broken. The filament is somewhat suddenly narrowed at both ends to a tapering extremity, which bends downwards; otherwise it is quite straight. Endochrome a very bright blue-green, obscurely divided into pseudo-cells about three times as broad as long, much narrower in the curved ends; it shows here and there indications of breaking up into the "cellulæ perdurantes" described as specially characteristic of the genus *Lyngbya*.

This fine species was seen several times in bog pools; the filaments always moving backwards and forwards with a slow horizontal motion. It might readily, at first sight, be mistaken for a *Desmidium*, which it resembles in form and size. The thin mucous sheath, and the tendency of the contents of the filament to break up into resting-cells, seem to indicate an affinity with *Lyngbya;* but the form of the extremities of the filaments is altogether that of an *Oscillaria*. I have some doubt in identifying it with Vaucher's species, which is described by Rabenhorst as forming a mucous stratum, while this was observed by me only in rare solitary filaments. On the whole, however, it seems to agree with this species, though it also shows considerable resemblance in size, and in its solitary filaments, to *O. percursa* Ktz. *O. imperator* Wood I take to be identical.

The genus *Oscillaria* is at present very poorly represented in the British flora. Dr. Cooke includes only twenty species in his 'British Fresh-water Algæ; while Rabenhorst, in his 'Flora Europæa Algarum,' enumerates no less than sixty-four, many of them, however, of only very doubtful value. The larger species in particular are conspicuously absent from our flora; and the addition of this, perhaps the most striking of all, is therefore of some interest.

Lyngbya ochracea Thur.
*Spirulina oscillarioides Turp. Bog pool, Roche.

Sirosiphoneæ.

*Stigonema minutum Hass.? Figs. 5–10.

Whether this species is correctly named I am very uncertain. Isolated fragments were observed several times, intermixed with other floating algæ, on a bog pool at Mawgan. The main filament averages about 40 μ in thickness; from this proceed branches on one side only, frequently in pairs, these again branching copiously; the average thickness of the branches is about 25 μ. There was no indication of a mucous sheath. The branches contain a single row of elliptical pseudo-cells, the broader axis at right angles to the direction of the filament;

but in places the pseudo-cells were arranged in two rows, and they were then smaller and nearly spherical. In the main filament there were mostly two rows of nearly spherical, interspersed with a few larger elliptical, pseudo-cells in a single row. The largest of these pseudo-cells were about 32·5 μ by 20 μ. The contents of the pseudo-cells were brown in the main filament, more often a light green in the branches; the entire filament externally to the pseudo-cells being also filled with a light brown endochrome.

Following Rabenhorst, Dr. Cooke regards *Stigonema* as a genus of lichens. Whether this view is correct or not I express no opinion; but the organism here figured, which agrees with the general description of the genus, unquestionably carries on an independent existence, like any other fresh-water alga or protophyte. As Cooke's figure appears to be taken from a dried specimen only, I have presented, by way of comparison, one from the living plant.

NOSTOCACEÆ.

*Anabæna flos-aquæ Ktz. Frequent.
Cylindrospermum macrospermum Ktz.
Nostoc hyalinum Benn. (Journ. R. Micr. Soc., 1886, p. 4, t. i. f. 2, 3).

This pretty *Nostoc*, obtained last year in the Lake District, was again observed, but only once, in a bog pool at St. Denis. I am unable to accept Dr. Cooke's suggestion that it is identical with *N. minutissimum* Ktz., the mature "frond" differing from that species in size, in the degree of complexity of the trichome, and in other points.

ALGÆ.

PEDIASTREÆ.

Pediastrum Boryanum Turp.
„ Ehrenbergii Br.
* „ rotula Br.
**Pediastrum* (*Anomopedium*) *integrum* Näg. Figs. 11–13.

This interesting *Pediastrum* represents a section of the genus not hitherto detected in Britain, distinguished by the peripheral cells being neither lobed nor incised. The cœnobium consists of 8–16–32 cells, and is nearly round or irregularly oval, when mature about 125 μ long by 100 μ broad, compact, without any intercellular lacunæ. The cells are very regular and thick-walled, about 25 μ in diameter, the central ones symmetrically hexagonal, the peripheral cells alternately obscurely hexagonal and obscurely pentagonal, with rounded outer margin, not differing in their endochrome from the central cells. In an early stage, when the cœnobium consists of eight cells, each peripheral cell has a single central short obtuse hyaline process; at later stages each peripheral cell has usually two such processes at the obscure angles, one pointing upwards, the other downwards; but one or both may be entirely wanting. On losing their hyaline processes the peripheral cells exhibit a tendency

to round themselves off, the endochrome becoming at the same time darker in colour (*a*, fig. 13), possibly the commencement of the formation of reproductive resting-cells.

My plant agrees very closely with Nägeli's description and figure (Gatt. Einzell. Algen, p. 96, t. v. B. f. 4). It was observed only on the wet sides of a well at Tintagel, where it appeared to be abundant. It is recorded from several places in Germany.

Sorastreæ.

*Cœlastrum sphericum Näg. Bog pools, frequent.

**Cœlastrum cubicum* Näg. Fig. 14.

Cœnobium free-swimming, about 45 μ in diameter, composed of eight cells arranged in a cube. The front view shows a rectangular space in the centre surrounded by four nearly spherical cells, very obscurely hexagonal in outline, 22·5 μ in diameter, with homogeneous bright green endochrome. Each cell has two blunt shallow hyaline processes at the outer corners, and there is also a shallow hyaline band in the sinus between each pair of cells.

I cannot find that this very pretty organism has been seen or described except by its discoverer (Nägeli, Gatt. Einzell. Algen, p. 97, t. v. C. f. 2), whose figure is evidently imperfect. Rabenhorst is certainly in error in identifying it with *C. sphericum*, from which it is abundantly distinct. In bog pools, Mawgan, apparently not uncommon.

*Selenastrum bifidum n. sp. Figs. 15 and 16.

Cœnobium free-swimming, nearly spherical in outline, about 60 μ in diameter, composed of 8–16 cells. Cells bright green, somewhat broadly lunate, all with their apices pointing outwards, narrowing towards each apex, which ends in two straight hyaline processes, from one-fifth to one-sixth the length of the cell, about 35 μ long (without the spines) by 15 μ broad.

The genus *Selenastrum*, distinguished by its lunate cells, has been hitherto represented in our flora only by the doubtful species *S. Bibrianum* Reinsch. The present species comes near to *S. gracile* Reinsch, but is distinguished by the cells being broader in proportion to their length, and bidentate at the apex instead of simply falcate. It was seen frequently in gatherings from bog pools, Mawgan.

**Sorastrum bidentatum* Reinsch. Bog pool, Mawgan.

Pandorineæ.

*Eudorina elegans Ehrb.

In a roadside ditch, Roche, among *Zygnema insigne*, very abundant; also in running water and in bog pools, Mawgan. In none of a large number of individuals under observation was a red "eye-spot" detected.

*Gonium pectorale Müll.

Roadside ditch, Roche, with the preceding. When observed it was always swimming with the "frond" placed vertically.

ULVACEÆ.

*Prasiola crispa Ktz. On damp ground, valley of the Gannel, frequent.
* „ furfuracea Menegh. On a water-wheel in the valley of the Gannel.
* „ calophylla Menegh. With the preceding.
*Enteromorpha intestinalis Lk.

Very abundant on moist ground, valley of the Gannel, only slightly above high-water mark.

*Monostroma Wittrockii Born.

Along with *Prasiola furfuracea* and *calophylla*. Dr. Cooke hesitates on placing this species among fresh-water algæ; it is certainly, according to my observation, entitled to a position there.

ULOTRICHACEÆ.

Hormiscia moniliformis Rabh.
„ cateniformis Ktz.
Ulothrix zonata Ktz.

CONFERVACEÆ.

*Cladophora flavescens Ag.
Conferva fontinalis Berk.
„ bombycina Ag.
Microspora vulgaris Rabh.
„ floccosa Thur. Very commonly more or less of a brown tint.
*Chætomorpha Linum Ktz.

Fresh-water stream, Mawgan, along with several species of *Spirogyra*. Cells varying greatly in colour in the same filament.

* „ implexa Ktz. With the preceding.
*Rhizoclonium Casparyi Harv. With the two preceding species.

DIATOMACEÆ.

*Epithemia turgida W. Sm.
Eunotia Arcus W. Sm.
Cymbella affinis Ktz.
Surirella biseriata Bréb.
„ linearis W. Sm.
„ pinnata W. Sm.
* „ splendida Ktz.
* „ constricta W. Sm.
Nitzschia sigmoidea W. Sm.
„ linearis W. Sm.
„ Amphioxys W. Sm.
*Amphora ovalis Ktz.
Navicula rhomboides Ehrb.
„ rhyncocephala Ktz.
„ ovalis W. Sm.

Pinnularia major W. Sm.
„ viridis W. Sm.
„ oblonga W. Sm.
„ radiosa W. Sm.
„ gracilis Ehrb.
Stauroneis Phœnicentron Ehrb.
„ gracilis Ehrb.
Synedra radians W. Sm.
„ Ulna Ehrb.
„ fasciculata Ktz.
* „ capitata Ehrb.
Gomphonema constrictum Ehrb.
„ acuminatum Ehrb.
Himantidium pectinale Ktz.
*Odontidium mutabile W. Sm.
Fragilaria capucina Desm.
Diatoma vulgare Bory.
„ elongatum Ag.
Tabellaria flocculosa Ktz.

DESMIDIEÆ.

Hyalotheca dissiliens Sm. Comparatively very scarce.
* „ mucosa Ehrb.
Didymoprium Borreri Ralfs.
* „ Grevillei Ktz. Bog pools, Mawgan.
Sphærozosma vertebratum Bréb.
Docidium nodulosum Bréb.
„ truncatum Bréb.
„ clavatum Ktz. Very common in bog pools.
* „ Ehrenbergii Ralfs. Bog pools, Mawgan.
„ baculum Bréb.
*DOCIDIUM GRANULATUM n. sp. Fig. 17.

Frond minute, about five times as long as broad, 50 μ by 10 μ, slightly constricted in the middle, conspicuously covered with pearly granules. Endochrome dark green, with a lighter transverse band in the centre.

Bog pool, Mawgan, occasional. About the size of *D. minutum* Ralfs. Nearest to *D. asperum* Ralfs, from which it differs in its dimensions, in the central constriction, and in the ends not being dilated.

Cylindrocystis diplospora Lund. Frequent in bog pools.
Penium margaritaceum Ehrb.
„ cylindrus Ehrb.
„ digitus Ehrb. Much the most common desmid, and remarkably variable in size.
„ interruptum Bréb.
„ Brebissonii Ralfs.
Tetmemorus Brebissonii Menegh.
„ granulatus Bréb.
„ penioides Benn. (Journ. R. Micr. Soc., 1886, p. 13, t. ii. f. 26). Bog pool, Mawgan.

Spirotænia condensata Bréb.
,, obscura Ralfs.
Closterium lunula Ehrb.
,, turgidum Ehrb.
,, acerosum Schrank.
,, Ehrenbergii Menegh.
,, Dianæ Ehrb.
,, didymotocum Corda var. β Ralfs.
,, costatum Corda.
,, striolatum Ehrb.
,, juncidum Ralfs.
,, acutum Bréb.
* ,, setaceum Ehrb. Bog pools, Roche and St. Denis, occasional.
Micrasterias denticulata Bréb.
,, rotata Grev.
,, crenata Bréb.
Euastrum verrucosum Ehrb.
,, oblongum Grev.
* ,, oblongum var. INTEGRUM n. var. Fig. 18.

Frond about the size of the normal form, oblong in outline. Each frustule rather longer than broad, broadest at the base, 5-lobed; basal lobes nearly half the length of the frustule, concave; lateral lobes also concave; terminal lobe quite entire. Along the centre of each frustule is a row of conspicuous protuberances; and there are two other lateral protuberances in each frustule.

Peat bog, Mawgan. This form appears to be intermediate between *E. oblongum* Grev. and *E. multilobatum* Wood. It differs from the typical *E. oblongum* in little but the entire absence of the notch in the terminal lobe, which hardly seems sufficient for the establishment of a new species. Wolle (Desmids of the United States) also mentions the occasional absence of the notch.

Euastrum crassum Bréb.
* ,, crassum var. CORNUBIENSE n. var. Fig. 19.

Frond about the size of the normal form, 140 μ long by 105 μ broad at its greatest width. Outline of frustule without the terminal lobe nearly rectangular; sides nearly parallel; lower half somewhat convex, then a rounded projection, and terminating in a prominent cuneate shoulder. Terminal lobe emarginate, but not deeply notched. Two rows of large protuberances in each frustule, and in addition a protuberance in the lateral projections.

Bog pool, St. Denis. Closely resembles the very abundant *E. crassum*, with the exception of the projection below the shoulder.

Euastrum Didelta Turp.
,, ansatum Ehrb.
,, circulare Hass. var. *a* Ralfs.
,, pectinatum Bréb. Very abundant.
,, elegans Bréb. β inerme Ralfs.

Euastrum erosum Lund.
„ insulare Wittr.
„ binale Bréb.

*Euastrum crenulatum n. sp. Figs. 20 and 21.

Frond very minute. Each frustule 25 μ long by 11 μ deep, broadest at apex; with two teeth at each outer angle and one at the base; sides concave; apical edge with three concave crenations, of which the centre one is the largest. Isthmus 7 μ wide and deep, with a broad sinus on each side. Each frustule with three prominent protuberances.

Bog pools, not uncommon. This pretty desmid does not seem to come very near to any other species with which I am acquainted. The appearance presented by the end view indicates its right place in *Euastrum*. The front view strikingly resembles *Staurastrum Renardii* Reinsch; but the end view is totally different. *Cosmarium Regnesii* Reinsch is also somewhat similar in outline.

Cosmarium cucumis Corda.
„ pyramidatum Bréb.
„ crenatum Ralfs.
„ undulatum Corda.
„ tetraophthalmum Ktz.
„ botrytis Bory.
„ margaritiferum Turp.
„ Brébissonii Menegh.
„ speciosum Lund.

*Cosmarium sphericum n. sp. Fig. 22.

Frond moderately large. Frustules very nearly spherical, about 45 μ long and broad, covered with very prominent projections, which give them a very deeply crenulated edge; sinus rather deep. Endochrome very dark green.

The frustules of this very beautiful desmid are more nearly spherical than those of any other species of nearly the same size. It is further distinguished by the very conspicuous papillæ which cover the whole surface, resembling those of *C. cristatum* Ralfs, and by the deep green of the abundant endochrome. It comes near to *C. Brebissonii* Menegh., but the frustules are more nearly spherical, and to *C. Logiense* Biss. (Journ. R. Micr. Soc., 1884, p. 194, t. v. f. 4), but the description of the latter is hardly full enough for identification; *C. orbiculatum* Ralfs is considerably smaller. I found it not unfrequently in gatherings from bog pools.

Cosmarium cœlatum Ralfs. Common.
„ ornatum Ralfs.
„ cristatum Ralfs.
„ cucurbita Bréb.
* „ Broomei Thw. Bog pool, St. Denis.

*Cosmarium discretum n. sp. Fig. 23.

Frond small. Frustules nearly semi-elliptical or slightly reniform, 37·5 μ by 17·5 μ, rough with pearly granules. Isthmus very con-

spicuous, separating the two frustules widely from one another, 11 μ long by 6 μ wide, quite colourless. Cell-membrane punctate, and with five distinct protuberances in each frustule.

Bog pools, Roche and St. Denis. Nearest to *C. excavatum* Nordst., but larger; *C. Portianum* Arch. belongs also to the same section.

*Cosmarium bioculatum Bréb. Bog pools, not unfrequent.
„ moniliforme Turp.
* „ Meneghinii Bréb. Bog pools, Roche and St. Denis.
„ Wittrockii Lund.
Xanthidium aculeatum Ehrb.
„ fasciculatum Ehrb.
* „ cristatum Ehrb. var. *a* Ralfs. Frequent.

This species is well distinguished by the solitary basal spine, which is, however, frequently rudimentary or altogether wanting.

Staurastrum dejectum Bréb.
„ Dickiei Ralfs.
„ muticum Bréb.
„ teliferum Ralfs.
„ Pringsheimii Reinsch.
„ alternans Bréb.

*Staurastrum (Didymocladon) cornubiense n. sp. Fig. 24.

Frond minute, 35 μ long, 28 μ broad. Each frustule elliptical, but with the lower edge flatter than the upper rounded edge, 2–3-dentate at the base, and with a bifurcate colourless process on the shoulder. In front of each frustule is a large ovate protuberance, much deeper green than the rest of the frond, ending in two bifurcate horns, 14 μ long including the horns, 7·5 μ broad.

Bog pool, Roche, occasional. Belongs to the section (Ralfs's genus *Didymocladon*) in which each frustule is furnished with bifurcate processes. It is considerably smaller than most of the section, resembling most nearly, in this and other respects, *S. pseudofurcigerum* Reinsch, but the very remarkable urn-shaped protuberance well distinguishes it from all other forms yet described.

Staurastrum polymorphum Bréb.
„ gracile Ralfs.
* „ cyrtocerum Bréb. Bog pool, Mawgan.
* „ paradoxum Mey. Bog pools.
* „ tetracerum Ktz. Bog pools.
Arthrodesmus Incus Bréb.
„ convergens Ehrb.

Zygnemaceæ.

Spirogyra porticalis Vauch.
„ longata Vauch.
* „ nitida Dillw. Mill-dam, valley of the Gannel, and elsewhere, frequent.
*Zygnema insigne Hass. With the preceding.
„ Hassallii Benn.? (*Z. anomalum* Cooke). Not seen in conjugation.

MESOCARPEÆ.

Mesocarpus scalaris dBy.? Not seen in conjugation.
*Staurospermum capucinum Ktz. Bog pools, Mawgan.

SIPHONEÆ.

Vaucheria sessilis Vauch. Frequent.

ŒDOGONIACEÆ.

Bulbochæte pygmæa Wittr.
Bog pools and running water, occasional.

BATRACHOSPERMEÆ.

*Chantransia pygmæa Ktz.
In running water, Mawgan, along with a *Vaucheria* sp. indeterm., and several Zygnemaceæ and Confervaceæ.

P.S.—Since writing the above, I have seen Reinsch's paper on Lagerheim's genus *Acanthococcus* in the 'Berichte der deutschen botanischen Gesellschaft,' and recognize one or more of his species as having been frequently seen by me in gatherings both in Westmoreland and Cornwall, but have not preserved exact descriptions or drawings. No species of the genus has as yet been recorded from the British Islands. Reinsch's surmise is probably correct, that they have been taken for zygospores of desmids. They should be looked for by other observers.

III.—*On Improvements of the Microscope with the aid of New Kinds of Optical Glass.**

By Prof. E. Abbe, Hon. F.R.M.S.

(*Read 13th October*, 1886.)

Since the year 1881, Dr. Schott, of Jena, and the author, with active co-operation from the optical workshops of Zeiss, have undertaken a prolonged investigation into the improvement of optical glass, the result of which has been the production of new kinds of glass for the use of opticians.

By spectrometric observation of numerous experimental fusions, systematically carried out with a great variety of chemical elements, the relation between the optical properties of the amorphous (glassy) products and their chemical composition has been more closely investigated; and on the basis of the results so obtained suitable syntheses have been made by which it has been possible to produce glass having desired optical properties.

In this way, by the use of many more chemical elements than have hitherto been employed in the manufacture of glass, especially by the use of phosphoric and boric acid as essential constituents of glass fluxes, where formerly silica was alone used, two hitherto unattainable requirements of practical optics have been satisfied. In the first place, crown and flint glass can be produced in which the dispersion in the different parts of the spectrum is nearly proportional, so that in achromatic combinations it is now possible entirely, or almost entirely, to do away with the hitherto unavoidable secondary spectrum; secondly, the kinds of glass which can be used for optical purposes have been so increased in variety that, while the mean index of refraction is constant, considerable variations can be given to the dispersion, or to the refractive index while the dispersion remains constant; in particular, a high index of refraction is no longer necessarily accompanied by a high dispersion (in flint glass), but may be retained (in crown glass) with a low degree of dispersion.

The regular supply of optical glass in answer to such increased demands seems to be insured for the future, since as a direct result of the above-mentioned experiments, and with the co-operation of the Royal Prussian Education Office, a glass factory has been established at this place (the Glastechnisches Laboratorium of Jena), which has meanwhile commenced the manufacture of all kinds of optical glass for general use.

The circular which has recently been issued by this institution gives preliminary information of a more detailed character to those who are interested in the subject, prior to the appearance of a complete description of the results of the experiments.

The new materials which are thus placed at the disposal of practical optics by an extension of glass manufacture from a scientific point

* The original paper is written in German (translated by Mr. H. A. Miers of the British Museum, Natural History, and revised by the author). Cf. SB. Jen. Gesell. f. Med. u. Naturw., 9th July, 1886, 24 pp.

of view, introduce considerable changes in the fundamental treatment of dioptrical problems, and are calculated to open up in different directions paths for the development of optical instruments which have hitherto remained closed.

As regards the Microscope, an endeavour has been made to obtain improvements with the help of these materials through the workshops of Zeiss, the author having undertaken the necessary theoretical investigation. The following is a notice of the aims at which this research was directed, and the results to which it has led.

Objectives.

By judicious use of the new glass-fluxes, and particularly those which have been produced by the aid of phosphoric and boric acid, together with silicate glass of different compositions, it is possible to remove two important defects in regard to objectives, which have hitherto placed insuperable obstacles in the way of the further perfecting of the Microscope, since they could not be overcome with the means hitherto available.

Complete achromatism has always been unattainable on account of the great disproportionality of the dispersion at different parts of the spectrum, which is peculiar to the ordinary crown and flint glass. In the best objectives it has not been possible really to unite more than two different colours of the spectrum; the inevitable deviation of the rest—the so-called secondary spectrum—always left coloured circles of dispersion of appreciable extent and intensity. Besides this, it has been impossible with the glass hitherto available, at least with types of construction which could be used in practice, to correct the *spherical* aberration for more than *one* colour. With all objectives, when the spherical aberration has been removed as far as possible for the centre of the spectrum, there has remained a spherical under-correction for the red, and an over-correction for the blue and violet rays, and this defect has made itself felt in practice as a more or less marked inequality between the *chromatic* corrections for the central and the peripheral zones of the objective.

Both these defects unite in making the concentration of the rays in the image formed by the objective less complete in proportion as the aperture of the objective increases; therefore, in objectives of considerable aperture, the available magnifying power is reduced to such as can be obtained with relatively low eye-pieces, because with higher eye-piece magnification the imperfections of correction become inconveniently visible, and necessitate the employment of objectives of very short focal length, if a high magnifying power with an image of satisfactory definition (therefore with a low eye-piece) is to be obtained.

Both these imperfections in the convergence of the rays in the achromatic objectives hitherto used can now be as good as entirely eliminated by the use of the new glasses.

In the first place the secondary chromatic deviation is removed and reduced to a practically harmless residue of colour of a *tertiary* character, and this has not been hitherto even approximately effected in any kind of optical construction. Secondly, the chromatic difference of

the spherical aberration can be eliminated, that is to say, the spherical aberration can be completely corrected for *two different* colours of the spectrum at once (and therefore practically so for all colours).

The latter object has hitherto been attained in certain kinds only of telescope objectives, for which it was originally formulated by Gauss, without however—for want of a simultaneous correction of the secondary dispersion—any decided advantage being gained.

The fulfilment of the first condition depends upon the employment of pairs of glasses in which the so-called relative dispersion, the quotient $\frac{\Delta n}{n-1}$, differs considerably, while the ratio between the partial dispersions at different parts of the spectrum is at least approximately constant, or in which on the other hand the quotient is constant while the latter ratio is different. Now this is entirely a matter of the chemical composition of the glass; the experimental researches mentioned at the outset, have established the fact that in the series of silica glasses this requirement cannot be satisfied, but it is so when phosphates and borates are used in combination, the former as a substitute for crown, the latter for flint glass. The circular of the Glastechnisches Laboratorium gives the results of the spectrometric measurements of a number of such glasses, and thus supplies the requisite data for their application to the purpose in question by means of the usual methods of calculating the colour dispersion in optical systems.

The second requirement, which refers to spherical aberration, involves in the case of systems of so great an aperture as are used with the Microscope, the consideration of very complicated relations between the separate elements of the system which have not yet been expressed in a general form in the theory of dioptrics. So far as the author can at present see, the correction of these aberration differences depends upon a very *pronounced* accumulation of spherical deviations in one part of the system, which are compensated for by equal and opposite deviations in another part. If these purposely produced accumulations are to be correctly compensated, the possibility of varying the index of refraction independently of the dispersion, as may be done with the new glasses, will be an indispensable aid.

It was made clear from the theoretical consideration of the conditions of delineation, and it was practically proved by the objectives which have since been produced, that by the *simultaneous* fulfilment of both these requirements the *concentration of the rays* in the images formed by these objectives is essentially more perfect. Apart from the unusual purity of colour in the images, which is almost as perfect with oblique as with central illumination, the better or more complete concentration of the rays is evinced by the fact that the images may be further magnified by very high eye-pieces without appearing indistinct, and without producing the impression of insufficient light, provided only that the mechanical construction has been improved proportionately with the optical action.

As has been said above, the condition by which these properties are obtained in the new objectives, and the characteristic which distinguishes them from the dioptrical point of view, depends upon the elimination of

those errors which, while they have to a certain extent the character of spherical aberration, originate mainly in the unequal behaviour of differently *coloured* rays; in fact the elimination of these errors realizes an *achromatism of higher order* than has hitherto been attained. The objectives of this system may be therefore distinguished from achromatic lenses in the old sense of the word, by the term *apochromatism*, and may be called *apochromatic objectives.*

The practical advantages gained by these improvements are as follows:—

Firstly, the aperture of the objective can now be utilized to its full extent. In the case of the old objectives of somewhat considerable aperture, the inevitable defect in the convergence of the rays has to a great extent prevented a proper combined action of the outermost zone and the central parts of the aperture; for this reason it has never been possible to realize such a degree of resolving power as is to be expected by theory from a given aperture. In practice, therefore, these objectives perform like ordinary objectives of perceptibly *greater aperture.* For example, a dry objective of aperture scarcely greater than that of the higher dry systems at present used, gives with central illumination an image of *Pleurosigma angulatum*, which for clearness and distinctness of definition can scarcely be distinguished from the image obtained with good water-immersion lenses of the existing type. The water-immersion objectives are in the same way shown by corresponding observations to have an optical efficiency at least equal to that of the old homogeneous-immersions, if we do not take account of the practical advantage of the latter in dispensing with the cover-glass correction. The advantage is conspicuous with illumination by a *broad* central cone of light such as is given by a wide diaphragm.

In the second place, since with the new objectives there are no longer the same obstacles to a considerable increase of magnifying power *by the eye-piece,* the greatest magnifying power which can be utilized with a given aperture may now be obtained with an objective of relatively greater focal length, and very short focal lengths are rendered unnecessary.

Former investigations made by the author* have shown that with the best objectives of the old kind and with large apertures, the limits of a completely satisfactory clearness of image, such as is required in difficult observations, are reached when the *super*-amplification is 4–6 fold; that is to say, when the total magnifying power of the objective and eye-piece together is 4 to 6 times as great as that obtained with the objective when used by itself as a magnifying lens. Under these circumstances, to obtain a magnifying power of 1200—e. g. with an objective for homogeneous immersion—under satisfactory conditions, it is necessary to use an objective which has by itself a magnifying power of 200, and consequently a focal length of only $\frac{250}{200} = 1 \cdot 25$ mm. On the other hand, a number of careful comparisons have shown that with the apochromatic objectives the available super-amplification, even with

* "On the relation of Aperture and Power," see this Journal, 1883, p. 803.

the greatest apertures, is at least 12–15, and considerably higher with the medium and low objectives. A total magnifying power of 1200 requires therefore no more than an objective amplification of 80–100, and consequently it can now, with the help of higher eye-pieces,* be obtained with an objective of 3 to 2·5 mm. focal length, whereas it was formerly only possible with a focal length of 1·25 mm.

Even if but little value is attached to the removal of the inconvenience which unavoidably accompanies the use of objectives of very short focal length, there is *one* essential advantage gained at any rate: the limits within which each objective may be used are very materially extended, for a series of very different amplifications may be obtained by merely changing the eye-piece. It is clear that an objective of 3 mm. focal length, which by means of an eye-piece of suitable strength secures a magnifying power with good definition of 1200–1500, is in this respect of *greater* value than an objective of the much shorter focal length which has hitherto been necessary, because the former includes in itself the performance of a medium objective when a low eye-piece is employed.

Thirdly and lastly, the realization of an achromatism of higher order in microscopic objectives is of particular value in relation to photomicrography, because the correction errors of the ordinary achromatic systems exercise a disturbing influence in this case to a much greater extent than in observation with an eye-piece. As a result of these there is not only a considerable difference of focus between the optically and chemically active rays, which renders the correct adjustment for the photographic focus very doubtful, but in addition, since the spherical correction of the objective can only be effected with certainty for the brighter visible light, there always remains a marked spherical over-correction for the chemical rays which lie near the violet end of the spectrum, and on account of this the concentration of rays cannot be made so complete in the photographic image as with eye-piece observation. Both these defects are remedied in the apochromatic objectives, the former by the removal of the secondary colour-deviation, the latter by the production of a uniform spherical correction for *all* colours. Those objectives will therefore insure that the best chemical image shall lie in the same plane with the best optical image, and that the action of the former shall be as perfect

* With regard to the very general idea that the use of strong eye-pieces is *in itself* disadvantageous—that they involve loss of light, and that it is therefore essentially necessary for high magnifying powers to employ objectives of short focal length and low eye-pieces—it may be remarked that this view can neither be optically justified, nor does it correspond to a rightly interpreted experience, but has arisen in an unwarranted generalization from certain observations. "Dark" images are given by high eye-pieces if their use gives a *too great* (empty) magnifying power, i. e. if the total magnifying power rises above that value for which the details of the image, as determined by the aperture of the objective, are exhausted for the eye; and also if the concentration of the rays by the objective is so incomplete that it does not admit of the full magnifying power without at the same time making the defects visible. If neither of these conditions holds, the subjective impression of brightness is not affected, whether the magnifying power is obtained by the use of a strong objective with a low eye-piece, or by a weaker objective *of the same aperture* and a high eye-piece. The physical brightness of the image in every case depends only upon the aperture and the total magnifying power, and it is of no account in what way the latter is produced by means of focal length of the objective, length of tube, and focal length of eye-piece.

in regard to definition as the impression which is produced upon the retina by the latter.

According to theory, the photographic depiction of the microscopic image ought to have a not inconsiderable advantage as compared with eye-piece observation, on account of the essentially shorter wave-length of the light which is employed in the former case; with photography the objective produces an effect equal to an increase of aperture in the ratio of about 4 : 3 as compared with eye-piece observation. If, hitherto, as it appears, such an advantage has not been apparent in practice, the cause must be, in accordance with what has been said above, that the images formed by the chemical rays have never been so perfect, as regards concentration, as the visible images, and that this defect has counterbalanced the advantage of shorter wave-length. Experiments which have since been made with some of the objectives, constructed on the new principles, give ground for the expectation that in future the theoretical superiority of the photographic method will be realized.

The above-mentioned aims for the improvement of objectives, as well as indications of the way in which they are to be practically secured, were stated by the author some years ago.* He has also described experimental objectives which, with the use of strongly refracting liquids in the form of inclosure-lenses were made as early as 1873 in Zeiss's workshops,† with the object of practically testing his views, and, in the words which he then used, of getting "a glance at the Microscope of the future." So far therefore the present objectives are only the final elaboration of a plan for the improvement of the Microscope which has been pursued in these workshops for many years, but which remained so long in suspense because the glass manufacture could not supply the requisite material.

The elaboration of this plan has moreover led to a further advantage which, though of secondary importance, yet appears to be a desirable improvement. In all objectives of large aperture, in which the front-lens cannot be made achromatic by itself, there remains, even when the colour deviation along the axis (i. e. in the centre of the field) has been corrected as completely as possible, a not inconsiderable difference in the *magnifying power* for different colours (difference of the focal *length* of the objective for different colours when the position of the anterior focal *point* is the same), and this gives rise to marked colour deviation *outside* the centre of the field which makes itself apparent in conspicuous borders of colours at the margin. (The image formed by the blue and violet rays is *larger* than that of the red and yellow, it coincides with the latter at the centre of the field but extends over it more and more towards the margin.)

This defect of amplification cannot be corrected even in the apochromatic objectives except by very inconvenient methods of construction; but whereas the ordinary achromatic objectives are further complicated

* 'Bericht über die wiss. Apparate auf der Londoner Internationalen Ausstellung i. J. 1876' (Hofmann) 1878, pp. 415–20. See this Journal, 1884, p. 291.

† 'On new methods for improving Spherical Correction, &c.,' see this Journal, 1879, pp. 815–7.

by the fact that the amount of this difference in the colour amplification is very unequal in the central and peripheral parts of the *objective-opening*, in the apochromatic objectives it is approximately constant for all parts of the opening, and consequently allows of *correction by means of the eye-piece.*

For this purpose it is only necessary to construct the eye-piece in such a way that it may have an equal but opposite difference of magnifying power (or focal length) for different colours, that is, to use eye-pieces which are to a definite extent *un*achromatic. To effect this object it is necessary, if the eye-pieces are to be used with different objectives—as must of course be the case—that this difference of magnifying power for different colours should be made approximately the same in all objectives. This renders it necessary that objectives of small aperture (in which the difference of amplification can be easily avoided and which are usually found free from any such defect) must be *purposely* made defective in this respect to exactly the same extent as is the case in the objectives of large aperture in which it is unavoidable.

The result of this innovation is that now even objectives of relatively large aperture will give images very free from colour over the whole field, while their construction need not be more complicated for that purpose.

As regards the production of a *series* of objectives corrected in the above-described manner and satisfying the different practical requirements, the same considerations hold good which were formerly developed by the author with reference to the conditions of construction then existing. The altered conditions, as regards the degree of concentration of the rays attainable, can be expressed by modifying the numbers there given.

As the starting-point for each construction, the numerical aperture must be taken which finds its expression in the ratio of the free opening of the objective to its focal length. The superior limit of this element is in every class of objectives—dry, water-immersion, or homogeneous-immersion—almost invariably determined by the theoretical maximum; within this limit the determination of a particular value for a definite purpose remains a matter of free choice. When once the aperture is fixed it determines the type of combination of the lens system in general, and thence also the choice of the separate elements by which the requirements of the different conditions of correction are to be satisfied; the only point which remains open is the focal length with which the aperture in question is to be associated, that is the scale of construction, or the absolute dimensions of the system.

The choice of the focal length or the scale for a rational construction is based on the following considerations:—With the aperture are determined, on the basis of well-known and generally accepted laws, the linear measure of the smallest detail of the object which can be delineated by means of this aperture; the measure may be very approximately expressed numerically for every aperture.

It is then necessary that the smallest detail which can be reproduced in the image should be presented to the eye under a visual angle which is large enough for its clear perception, and the determination of this is

derived from known experiments. From these two data—the absolute size of the smallest reproducible detail in the object and the requisite visual angle of the same detail in the image—may be deduced the minimum value of the magnifying power which a Microscope with the given aperture *must* have if this aperture is to be fully utilized. On the other hand, it must be remembered that an increase of the visual angle beyond a certain small multiple of the value necessary for clear vision leads to an *empty* magnifying power which has no advantage for any purpose, and this multiple gives the maximum value which the total magnifying power of the Microscope does *not need* to exceed with the given aperture. In this way are obtained the limits of the *useful* magnifying power of an objective of given aperture.

The focal length which must be given to the objective *in order that by means of the eye-piece the magnifying power of the Microscope may be conveniently varied within these limits,* will depend entirely upon what proportion of the total magnifying power of the Microscope is to be obtained by the eye-piece.

On optical grounds there would here be no limitation if an absolutely perfect collection of the rays could be secured in the image formed by the objective. The division of the whole magnifying power between objective and eye-piece, would in this case be entirely immaterial as regards the optical effect. A limitation is however necessitated by the unavoidably imperfect collection of the rays, a result partly of uncorrected residual aberration in the objective, and partly of defects in its mechanical construction which cannot be completely overcome by any art. From both these causes the image produced by the objective exhibits not sharp points but circles of dispersion of greater or less diameter, which, with increased magnifying power in the eye-piece are presented to the eye under an increased visual angle, so that the sharpness and distinctness of the image is more and more affected. Having regard to these circumstances, the question then arises: how far can the requisite useful magnifying power be produced by the action of the eye-piece without making the circles of dispersion visible in the image?

The circles of dispersion which result from insufficient collection of the rays are in their absolute magnitude, when reduced to the measure of the object, directly proportional to the focal length of the objective, provided objectives of the same type and the same technical perfection are compared. From this it follows that the visual angle which they subtend at the eye *with a definite total magnifying power of the Microscope,* the objectives being otherwise similar, must be inversely proportional to the ratio of the focal length of the whole Microscope with this magnifying power to that of the objective, or directly proportional to the ratio of the total magnifying power N to the magnifying power n of the objective used by itself without eye-piece. This ratio $\frac{N}{n}$ which represents the increase of the magnifying power due to the eye-piece, consequently determines in the case of objectives of equal perfection the point at which the circles of confusion are visible, that is to say, for each degree of perfection there exists a definite value of this ratio beyond which defects in the union of the rays in the image pass the limits of distinct vision.

When this critical value of the super-amplification has been determined for any class of objectives, it fixes the focal length which must be given to an objective in order that the previously determined useful magnifying power corresponding to the aperture may be realised under satisfactory conditions, that is, so that the defects of the image do not make themselves felt. The admissible value of the eye-piece magnification (as defined above) may be represented by a number ν, while the total magnifying power which will be required for complete use of the aperture may be indicated by N; the *proper* magnifying power n of the objective should then be $\frac{N}{\nu}$, and the focal length therefore $250\ \frac{\nu}{N}$ (mm.), when the numbers representing the magnifying powers are referred to the usual distance of vision of 250 mm. The estimation of the eye-piece magnification ν which is admissible with objectives of a given type, is therefore the factor which leads to a rational accommodation of focal length to aperture.

The determination of this figure is essentially a matter of experiment and practice, since it is not of general application, but can only be given with reference to a definite type of correction and a definite degree of mechanical perfection in the objective. Every advance in the direction of a more complete removal of spherical and chromatic aberration must naturally diminish the circles of dispersion in the objective image, and make itself perceptible through a higher value of the admissible eye-piece magnifying power, provided that at the same time the perfection of the workmanship satisfies the correspondingly increased requirements for the correction of errors of form and centering in the lenses.

As has been mentioned, objectives made of the new kinds of glass, corrected in accordance with the above-established conditions, and constructed with all possible skill, admit, as the author's observations show, of an eye-piece magnification (super-magnification) of at least 12–15, even with the greatest possible aperture, without rendering defects in the collection of the rays visible in the image. With the smaller apertures, such as are employed with the weaker dry systems, the admissible eye-piece magnification reaches much higher figures still. Consequently, in accordance with the rule given above, the highest *useful* magnifying power to be obtained by homogeneous immersion can be secured with an objective magnifying power of 80–100, and therefore with a focal length of about 3 mm., without loss in the perfection of the image. With the largest aperture of water-immersions, the focal length is about the same, and with the greatest aperture of a dry system about 4 mm.

That in future with objectives of this kind of correction focal lengths substantially less than 3 mm. will be in general superfluous, will be recognized, from what was said in the beginning, as a practical gain; and there appears, therefore, no reason why this consequence should not be practically realized. With dry systems, however, of considerably smaller apertures than 0·9, this theoretical determination of the focal length leads in some cases to such high values, that its practical application is inadvisable, since, especially with Microscopes of the Continental

type, it would be necessary to use eye-pieces of inconveniently short focal length to secure the necessary magnifying power. In the case of these weaker objectives, therefore, those of *shorter* focal length should be retained than are in themselves required for a given aperture.

A set of apochromatic objectives is constructed in the workshops of Zeiss in accordance with the principles here explained. In this series the apertures rise from 0·3 to 1·4; in each class—dry, water-immersion, and homogeneous-immersion—the theoretical maximum of aperture is realized to within 7 per cent. or less.

How far these innovations will prove of advantage in the scientific use of the Microscope can only be determined by long practice. As regards the point which is of the first importance for the extension of microscopic perception, the aperture, no essential change is introduced into practical optics by the new materials. Although a slight increase in the aperture is obtained, at least in comparison with that which has hitherto been advantageously employed with objectives for systematic work, yet *this* advantage is comparatively too small to be referred to as of decided importance. A substantial practical gain can only be expected from the internal perfection of the construction in the matter of the collection of the rays. Everything, therefore, is reduced to the question how far the visible action of this perfected construction which was indicated at the outset can be practically utilized in the Microscope, and herein are included the more complete utilization of aperture, or the reduction of the difference which has hitherto always existed between the theoretical and practical performance; the greater precision and distinctness of perception which is without doubt secured by the more complete collection of the rays; and, finally, the essentially more favourable conditions which are introduced in the operations of photo-micrography.

Whatever may prove to be the final result, the principle of construction of objectives as here developed must in any case lay claim to a certain interest from the purely optical point of view, as regards the essentially higher *order* of collection of rays which is realized by it.

In the language of dioptrics this order is determined by the number of rays *different* in direction of incidence or in refrangibility, which, in virtue of the conditions fulfilled by the optical system, are *completely* united in a single point in the axis.

Upon the number of these rays depend the greater or less limits within which the other rays may vary which are not completely, but only approximately united; and these limits are a natural measure of the more or less complete concentration of the rays altogether.

In this sense an ordinary simple glass lens represents a collection of the rays in its axis of the first order. The objectives of the large telescopes which are made now, exhibit for the most part a concentration of the third order, and it is only those telescopes which are made strictly after the Fraunhofer or the Gauss type of construction which attain the fourth order.

Now of the Microscope objectives which are here considered, those with the greatest aperture in the different classes have a concentration

of rays of not less than the eleventh order; *three* different kinds of rays are brought under strict conditions by the removal of colour-deviation, including secondary dispersion; *six* by the elimination of spherical aberration and its chromatic difference with such large aperture; and, finally, *two* more by the production of equal magnifying power for the different zones of the free opening. To this corresponds the enormous size of the free opening which is employed with Microscope objectives as compared with telescope objectives; whereas in the latter an opening which is only the tenth *part* of the focal length is quite exceptional, at least in the larger instruments, the Microscope objective of the present time requires openings the diameter of which are 2·8 *times* the focal length.

Eye-pieces.

The following out of the rules above indicated for the construction of objectives, has naturally given rise to increased requirements in the case of the eye-piece, which have not been hitherto taken into account, and the satisfaction of which has led to several new contrivances. With respect to these, the following considerations have been determinative.

In the first place, if the advantage of the new objectives which was pointed out above is to be realized, the eye-pieces to be combined with them must conform to the condition that they should be sufficiently achromatic in regard to the distance at which the differently coloured rays are united, whilst with respect to magnifying power they should behave as strongly *over*-corrected lenses, and the degree of over-correction should be quite definite, being determined by the corresponding deviation of the objectives of large aperture. To satisfy this quite unusual requirement, that the focal *length* of such an eye-piece must differ for different colours in exactly the opposite way to an ordinary unachromatic lens, no special difficulties are experienced in practical optics, and the object may be attained in the different types of construction by known means. Eye-pieces of this kind *compensate* for the chromatic difference in magnifying power of the objective, and they do this at the same time for different objectives if, as was said above, the latter are equalized so that this difference is the same for all. Having regard to this property, the eye-pieces in question are called *compensation eye-pieces.*

In the second place the demand, that with the new objectives a high magnifying power in the eye-piece should be provided for systematic work, requires a considerable alteration in the construction of the stronger eye-pieces so as to free them from the disadvantages by which they are at present beset. The types of eye-piece which have been hitherto used, both the ordinary Huyghenian and the different achromatic eye-pieces, if their focal length falls much below 25 mm., require eye-lenses of very small diameter, and moreover, with them the eye-point lies very close to the lens. On this account the observer must bring his eye inconveniently near, and in particular the use of the camera lucida is prevented. By a type of construction which is essentially different from the forms in use, the compensation eye-pieces may be rendered quite as convenient for the higher powers as is the case with the weak and

medium eye-pieces now employed. The diameter of the eye-lens is considerable, and the eye-point is so far from the lens *that the camera lucida may be used without any difficulty.*

Thirdly, the endeavour to realize as far as possible the advantage of an objective of relatively greater focal length, which was before indicated, has given occasion to extend the series of eye-pieces downwards also, below the present limits, so that for one and the same objective a very large variation may be given to the magnifying power. For this purpose two special eye-pieces of unusually long focal length have been made, the weakest of which produces an eye-piece magnifying power = 1 with the Continental tube, i. e. *which produces with every objective exactly that magnifying power which would be given by the objective used as a lens without any eye-piece.* These eye-pieces may appropriately be termed "*Searcher eye-pieces,*" because they are adapted not so much for systematic observation as for a preliminary view of and *search over* the object. Including these searcher eye-pieces, the whole series gives to each objective a range of useful magnifying power varying from 1 to 18, so that for example, a homogeneous-immersion objective of 3 mm. focal length, which gives a magnifying power of 1500 with the strongest eye-piece, when used with the weakest yields only the small magnifying power of about 80.

In the above discussion frequent use has been made of a method of characterizing the eye-piece by the ratio of the total magnifying power of the Microscope to that of the objective. The author has elsewhere established this method for determining the action of the eye-piece in the Microscope.* Attention may, however, here be called to the practical advantage of the method as a basis for a rational *designation of eye-pieces.*

If the combination of objective and eye-piece in a Microscope produces a linear magnifying power N, referred to the conventional image-distance l, this expresses the fact that under these conditions the Microscope *as a whole* forms a lens-system of focal length $f = \frac{l}{\mathrm{N}}$. Then for every system of lenses, whatever its construction, $\mathrm{N} = \frac{l}{f}$, and thus a definite value of N results *by virtue of* a definite value of f. To discover what proportion of the magnifying power of the whole Microscope belongs to the eye-piece, it is necessary to compare the instrument as it is *with* the eye-piece with what it would be *without* the eye-piece. In the latter case it is a system of lenses (the objective) with any other greater focal length F. The ratio between this focal length and that of the whole Microscope is therefore a numerical expression of the *eye-piece action in* the Microscope. This ratio is

$$\frac{\mathrm{F}}{f} = \frac{\mathrm{F}}{l}\,\mathrm{N} = \frac{\mathrm{N}}{\left(\frac{l}{\mathrm{F}}\right)},$$

* See this Journal, 1883, p. 791 *et seq.*

and since here $\frac{l}{F}$ denotes the magnifying power n which would be obtained from the objective alone, it follows that the total magnifying power of the Microscope should always be compared with the *proper* magnifying power of the objective, although the latter is not generally made use of, since Microscope objectives are not also used as lenses.

The division of the action of the whole Microscope between objective and eye-piece is therefore shown by the formula

$$N = n\,\nu;$$

where ν denotes the quotient $\frac{F}{f}$, the measure of the action of the eye-piece.

As the author has shown, the ratio $\nu = \frac{N}{n}$ determines at the same time the whole influence which is exercised by tube and eye-piece upon the character of the microscopic image. If in any Microscope the total magnifying power N exceeds the magnifying power n of the objective, say tenfold—as for example, if with an objective of 5 mm. focal length, of which the magnifying power determined in the usual way is only 50, the total magnifying power is brought to 500—then this number $\nu = 10$ denotes the whole optical conditions on which the character of the image under these circumstances depends. In particular, it is made clear that all faults of image formation which originate in the objective will be magnified exactly tenfold in the final image, whether this tenfold enlargement is produced by a long tube and weak eye-piece, or the reverse.

Now in practice, it is of considerable interest to be always reminded of this important factor in the use of the Microscope, and this can be accomplished if the designation of the different eye-pieces expresses directly the *super*-magnifying power which they produce. There is also here the further advantage that the total magnifying power is at once obtained by multiplying the number of the eye-piece by the proper magnifying power of the objective, which is given by its focal length.

This designation of the eye-pieces is adopted with the new constructions. Each eye-piece is denoted by a number representing the super-magnifying power which it gives to the Microscope with the normal length of tube for which it is constructed. Having regard to the prevalent confusion in the designation of eye-pieces, it would be a great advantage if opticians in general would adopt this method of rational notation.

In this system, of course an eye-piece can only have a *definite* magnifying-power number so far as it is used with a definite length of tube, because the action of an eye-piece depends not upon its focal length alone, but also upon its distance from the objective. The ratio $\frac{N}{n} = \nu$ employed above is always determined by the value of the quotient $\frac{\Delta}{\phi}$, where ϕ denotes the focal length of the eye-piece, and Δ is the dis-

tance between its lower focus and the upper focus of the objective, i. e. the "optical" tube-length. One and the same eye-piece will therefore give different *eye-piece* magnifying powers—just as it gives different values of the total magnifying power—according as it is used with a short or long tube, and these vary in exactly the same proportion as the distance Δ. Such alterations, which are produced in using the Microscope by pushing in or drawing out the tube, can be determined as regards their influence upon the *eye-piece* magnifying power just as readily as their influence on the total magnifying power. If it is known that the magnifying power ascribed to an eye-piece refers to an *optical* tube-length of say 180 mm., it is also known that an elongation of the tube by 20 mm. will raise the magnifying power of the eye-piece in the ratio of 180 : 200. In order to take account of all such alterations, it is only necessary that there should be given by the optician, or determined by the observer himself, the distance between the upper focus of the objective and the under focus of the eye-piece for that length of tube which is adopted as the *normal* length. If this is unknown it will be also impossible to determine the change produced in the total magnifying power of the Microscope by a change in the length of tube.

Contrivances for Projection.

To gain a complete idea of the advantages secured for photomicrography by the apochromatic objectives, special attention is finally directed to the means of projecting the image.

The methods hitherto employed for this purpose are all beset by considerable drawbacks. The simplest and apparently the surest plan, the direct projection of the image upon the photographic plate, always leads in the case of objectives of considerable aperture, to a deterioration of the image by spherical aberration as soon as the distance of the plate is much greater than the normal length of tube for which the objective is corrected. If the distance of the plate is great, these aberrations which are produced by the altered path of the rays in the objective cannot be entirely removed even by the correction-adjustment. It is true that these sources of error are eliminated by the projection of images with an eye-piece; but the ordinary eye-pieces, especially the unachromatic, lead for their part to other considerable errors, since they largely increase the difference of focus of the chemical rays. The use of an achromatic dispersive lens (amplifier) in place of an eye-piece, which has hitherto led to the relatively best results, introduces, apart from other objections, minute and troublesome manipulation in the adjustment, if a good correction of the objective is to be secured.

The method employed by the author, which disposes of these defects, seeks to produce the objective image under the same conditions and at the same point of the tube as with eye-piece observation, and then to project this image upon the plate (or a screen) by means of *a system of lenses accurately corrected for spherical and chromatic aberration*, which can be focused to the objective image in the tube.

This method makes it absolutely certain that the objective as corrected (by means of the correction-adjustment) for the eye, remains in exactly the same condition when the image is projected, and that

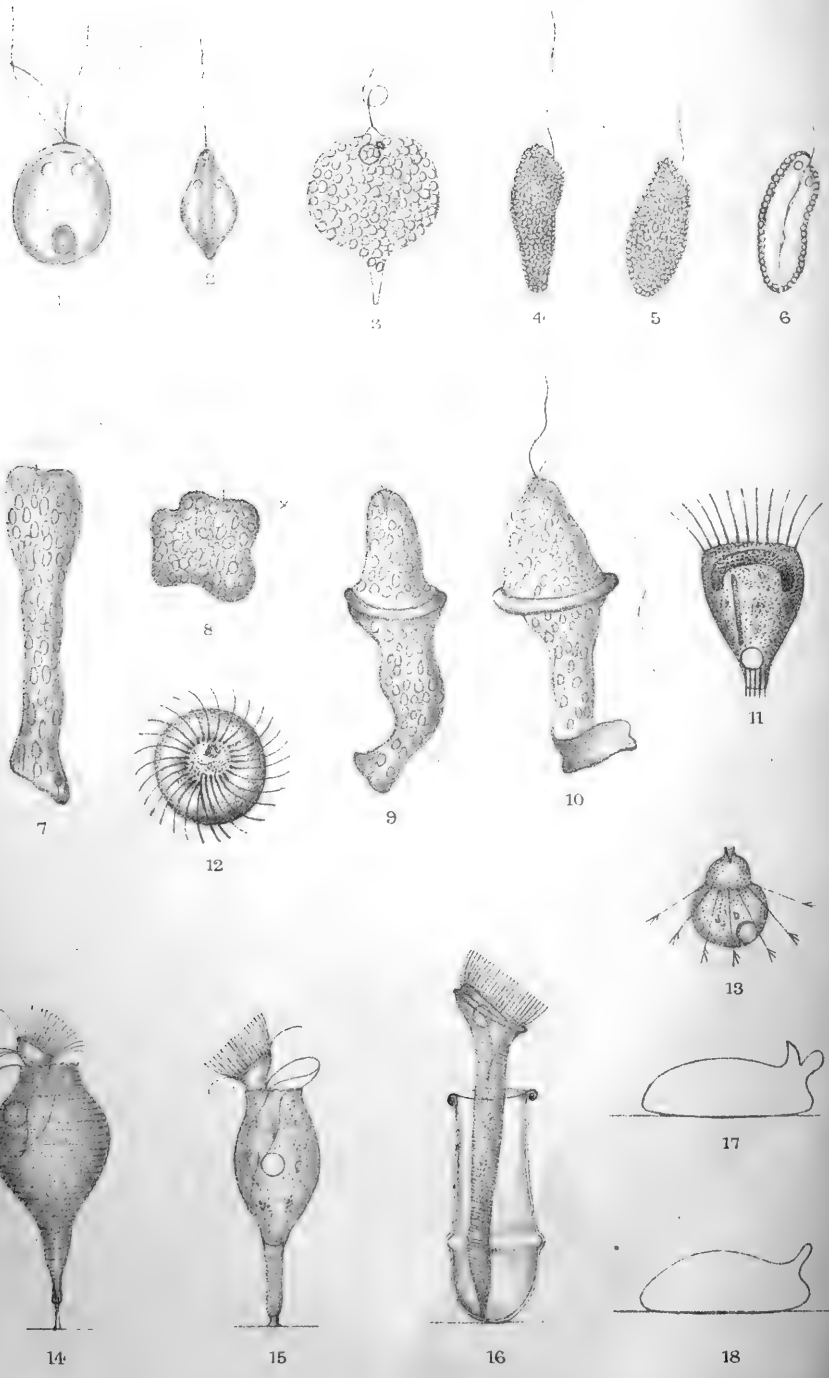
by the projection no new errors are introduced, since the projection system is corrected as well as the objective, and in particular is free from secondary colour dispersion and the focal difference which results from it.

In addition, care is also taken that in the final image the chromatic difference of magnifying power in the objective image is removed with the projection system just as it is with the compensation eye-pieces.

The whole manipulation for focal adjustment can be managed as well for short as for long distances of the plate, and is in this method particularly simple.

Such systems for projection, which are in external form like eye-pieces, and are attached to the Microscope in the same way, are designated *projection eye-pieces.*

The results already obtained by experienced photomicrographers by the employment of this method make it probable that it will come into general use in the future.



West, Newman & Co lith.

American Fresh Water Infusoria.

IV.—*Notices of new American Fresh-water Infusoria.*

By Alfred C. Stokes, M.D.

(*Read* 12*th January*, 1887.)

Plate V.

The ponds, marshes, and stagnant pools of the central portion of the eastern United States seem particularly favoured by the Infusoria. Within their shallows, beneath the shadows of their aquatic vegetation, or clinging to submerged leaflets, to floating objects, or to the nameless fragmental debris at the bottom, Infusoria abound in remarkable profusion. The student of these minute but charming forms of animal life has only to sweep his collecting vessel among the water-weeds, or gently scrape the soft ooze, to be amply rewarded, not only by Infusoria whose beauty shall stir his æsthetic nature, but with forms that will fill him with wonder at their variety of structure, movements, and habits. And another source of interest, if not of surprise, is that so great a proportion of the captives are new to science. To find Infusoria in American ponds and shallow pools that have also been found in European fresh waters is not common. There are cosmopolitan forms even in sweet water, but according to my somewhat limited experience, they are not abundant. What the American margins of the sea may reveal to the Microscope I do not know. It has never been my good fortune to be able to examine a drop of the ocean with Infusoria as the objects, and as far as I am aware, that field is here practically unexplored by any one.

In the neighbourhood of the writer's home in central New Jersey the level surface of the country is only at irregular intervals sufficiently hollowed to retain the water and produce permanent pools that shall resist the summer sun, but these little depressions are abundant; consequently marshy places, small lakes, and almost stagnant pools choked with *Sphagnum* are easily accessible, and wondrously rich in the lower forms of microscopic animal life. Rhizopoda, Infusoria, and aquatic worms abound, to say nothing of diatoms, desmids, and fresh-water algæ. It is from this limited but prolific region that the writer has taken the following hitherto undescribed Infusoria among many others. All the genera here referred to were originally discovered and described by

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EXPLANATION OF PLATE V.

Fig. 1.—*Tetraselmis limnetis* × 1100.
„ 2.—*Petalomonas pleurosigma* × 750.
„ 3.—*Chloropeltis monilata* × 585.
„ 4, 5, 6.—*Chrysomonas pulchra* × 675.
„ 7, 8, 9, 10.—*Zygoselmis mutabilis* × 170.
„ 11.—*Strombidium gyrans* × 360.
„ 12.— „ „ front view.
„ 13.—*Mesodinium fimbriatum* × 562.
„ 14.—*Pyxidium vernale* × 450.
„ 15.— „ *invaginatum* × 420.
„ 16.—*Vaginicola annulata* × 245.
„ 17.—*Lagenophrys labiata* × 486.
„ 18.— „ „ with closed lips × 486.

European observers, but these members of the genera have thus far been observed only in that part of America occupied by the United States, over which they are doubtless widely distributed. It has seemed preferable to describe their characters as concisely as possible, rather than to occupy space by the refinements of rhetoric, and so complicate subsequent reference and comparison.

Tetraselmis limnetis sp. nov., plate V. fig. 1.

Lorica broadly oval, the length but slightly exceeding the width, both extremities evenly rounded; body of the inclosed zooid almost entirely filling the cavity of the lorica, the endoplasm green, granular, with a small, colourless, transparent spot at the anterior border; flagella four, each exceeding the lorica in length; contractile vesicles two, small, situated one on each side of the frontal clear space; nucleus not observed; a large, subspherical amylaceous corpuscle posteriorly located. Length of lorica 1/1800 in. Habitat, pond water.

This is only the second known species of the genus.

Petalomonas pleurosigma sp. nov., fig. 2.

Body suboval or ovate, depressed, less than twice as long as broad, widest centrally, tapering towards both extremities, the anterior margin narrowly rounded, the posterior prolonged as a short, obtuse acumination; lateral borders more or less sigmoid; dorsal and ventral surfaces each traversed by a narrow, subcentral, longitudinal depression or furrow, which usually do not extend into the caudal acumination; oral fossa distinct, the flagellum apparently originating from one of its walls, and exceeding the body in length, the distal extremity alone undulating; nucleus and contractile vesicle distinct, situated opposite each other near the lateral margins of the anterior body-half. Length of body 1/1500 in. Habitat, standing pond water.

In the double sulcation of the flattened surfaces this form resembles *Petalomonas disomata* Stokes, but is readily distinguishable by the posterior acumination, the sigmoidal lateral margins, and the smaller size.

The writer, in the 'Annals and Magazine of Natural History' for February 1886, described an infusorian under the title of *Paramonas alata*, with a diagram. It is scarcely necessary to state that the generic name should have been *Petalomonas*, as the indurated and carinated cuticular surface at once relegate the animalcule to the latter position.

Chloropeltis monilata sp. nov., fig. 3.

Body broadly ovate or subcircular, strongly compressed, about one and one-half times as long as broad; general cuticular surface not ribbed but entirely covered with conical, rounded elevations arranged more or less in longitudinal series; caudal prolongation straight or slightly curved, forming less than one-fourth the length of the entire body; flagellum not exceeding the zooid in length; eye-like pigment-spot usually present; contractile vesicle conspicuous, anteriorly located. Length of body 1/650 in. Habitat, standing pond water.

This conspicuously differs from *Ch. hispidula* (Eichwald) Stein (the

only previously known species with a roughened cuticular surface), by the absence of a distinctly ribbed superficies, those longitudinal elevations in the European species being strongly hispid. In the present form the cuticular prominences are scattered over the general surface as well-marked conical monilations arising from rounded bases.

Chrysomonas pulchra sp. nov., figs. 4, 5, 6.

Body elongate ovate or obovate, somewhat flexible and changeable in form, three times as long as broad, tapering and slightly constricted posteriorly, curved toward one side anteriorly, the frontal border obliquely excavate; cuticular surface entirely covered with small, hemispherical elevations; flagellum scarcely equalling the body in length; contractile vesicle double, small, spherical, situated opposite to each other near the frontal border, and contracting alternately; nucleus ovate, occasionally becoming very conspicuous. Length of body 1/900 to 1/650 in. Colour, green. Habitat, marsh water, with *Sphagnum*.

This infusorian has the power to make conspicuous and quite rapid changes in its shape, the body at times becoming remarkably plastic; but this ability is seldom exercised to any extent greater than the assumption of an ovoid or subspherical form.

In figs. 4 and 5 are shown two forms of the body; in fig. 6, the infusorian in optic longitudinal section.

Zygoselmis mutabilis sp. nov., figs. 7, 8, 9, 10.

Normal contour of the body apparently elongate ovate, sub-cylindrical, but extremely soft, and incessantly and most irregularly changeable in form; surface longitudinally striate; flagella two, unequal, the longer equalling the extended body in length, the shorter about one-third as long; both apparently arising from the short, conical, oral fossa; endoplasm filled with dark-bordered, colourless corpuscles of various sizes. Length of the fully extended body 1/100 in. Habitat, standing water from the cypress swamps of South Florida.

The incessant alterations in the form of this curious infusorian are indescribable. The metabolic movements are seemingly endless, the endoplasmic corpuscles rushing from end to end of the body as it extends, contracts, twists, and contorts itself. In figures 7, 8, 9, and 10 a few of these changes are shown.

The food is indiscriminately animal or vegetable. The endoplasm of the individuals observed contained desmids, diatoms, and in a single instance, a small rotifer.

Strombidium gyrans sp. nov., figs. 11 and 12.

Body turbinate or obconical, less than twice as long as broad, the lateral border of the frontal margin with a conspicuous rounded elevation, the posterior extremity tapering and truncate; cuticular surface smooth, except at the posterior region, where there are a few longitudinal ridges which often extend slightly beyond the termination of the body; contractile vesicle apparently double, one large and situate laterally near the posterior extremity, the other (?) smaller and near the frontal

border; nucleus long, band-like, transversely placed close to the anterior extremity. Length of body 1/450 in. Habitat, standing pond water.

The movements are extremely rapid and erratic, the animalcule darting through the water by revolution on the longitudinal axis so rapidly as to defy examination. Fortunately, however, it has the habit of temporarily attaching itself to some supporting object by means of its posterior extremity, when it becomes comparatively quiescent; but even then it rotates on its long axis. At other times it swings to and fro in the field, describing a long curved path through the water as though it were attached to the end of a restraining but invisible thread.

This infusorian may readily be distinguished from all other known species of the genus by the long, band-like nucleus, an organ of this form not having been recorded as belonging to any previously described *Strombidium*.

I have not been able to positively demonstrate the presence of two contractile vesicles. The creature's movements are so rapid and erratic, that the study is difficult under any circumstances, but to observe a small, laterally developed pulsating vacuole while the infusorian is rotating and continually carrying the organ beyond the focus, is well nigh impossible. The posteriorly located vesicle is large and seen with comparative ease.

Mesodinium fimbriatum sp. nov., fig. 13.

Body divided into two unequal, subglobose regions by a transverse groove, from which springs the girdle of setose cilia, each of these appendages being distally cut into three or more unequal branches; cuticular surface obliquely and finely striate, so that the margins of the body, when examined from either extremity, present a crenulated outline; contractile vesicle large, spherical, located at one side near the posterior extremity. Length of body 1/1125 in. Habitat, standing pond water. Movements rapidly rotatory, with frequent lateral leaps.

The distinctly fimbriated condition of the locomotive cilia at once separate this from all previously known species.

In company with this interesting form there was present a *Mesodinium* corresponding in all essential characters with *M. pulex* C. & L., a species hitherto recorded from salt water alone. The only noticeable difference was in the size, the fresh-water variety being somewhat larger than the marine. The cilia of *M. pulex* are not fimbriated.

Pyxidium vernale sp. nov., fig. 14.

Body elongate vasiform, twice as long as broad, consisting of a subcentral, subspherical region suddenly constricted anteriorly to produce a short, neck-like prolongation, and lengthened posteriorly to form a portion tapering to the pedicle and constituting about one-third of the entire length of the zooid; peristome border crenulate; ciliary disc large, considerably and obliquely exserted, bearing three ciliary circles; vestibulum extending to near the body-centre; cuticular surface finely striate

transversely; pedicle short, slender; contracted body obovate, the subspherical central region then thrown into several annulations over the posteriorly tapering portion. Length of body 1/300 to 1/346 in. Habitat, shallow pools with algæ in early spring. Solitary or few together.

Pyxidium invaginatum sp. nov., fig. 15.

Body elongate urceolate, often somewhat gibbous, rather more than twice as long as broad, widest centrally, constricted anteriorly to form a short, neck-like region, and tapering posteriorly to produce a subcylindrical prolongation forming about one-third of the entire length of the zooid, a transverse cuticular fold usually encircling the body at the origin of the posterior prolongation; pedicle very short, usually only about one-fourteenth as long as the entire body; the cuticular surface finely striate transversely; ciliary disc conspicuous, furnished with two circles of cilia; peristome border truncate, crenulate, not everted, apparently supporting a conspicuous, collar-like membrane; contracted zooid ovate, frequently nodding, the posterior prolongation always invaginate within the central body-region, and the short pedicle invaginate within the posterior prolongation; vestibulum capacious, extending beyond the centre of the body, its walls ciliate at intervals; endoplasm colourless, transparent; contractile vesicle single, spherical, near the body-centre, and apparently communicating with the vestibulum. Length of the zooid, including pedicle, 1/300 in. Habitat, pond water; attached to the rootlets of *Lemna*.

This very characteristic *Pyxidium* is readily recognizable and easily separable from all previously recorded members of the genus, by the presence of the double posterior invagination so conspicuous in the contracted zooid. The cuticular striations are so extremely fine that they can be observed with difficulty, except when under the influence of oblique light.

Vaginicola annulata sp. nov., fig. 16.

Lorica broadly vasiform, somewhat more than twice as long as wide, rounded and inflated posteriorly, the frontal region slightly narrowed, the anterior border everted and narrowly revolute, the posterior region encircled by a single annular and horizontal inflation; the inclosed animalcule elongate obconical, the length about four times the width of the peristome, projecting, when extended, for about one-third its length beyond the lorica; peristome abruptly widened, twice as broad as the body, the ciliary disc obliquely elevated; cuticular surface transversely striated; contractile vesicle single, spherical, situated near the anterior border, apparently within the ciliary disc. Length of lorica 1/204 in.; length of extended zooid 1/150 in. Habitat, pond water.

The posterior annulation encircling the lorica and the very anterior position of the pulsating vacuole distinguish this species from the other members of the genus. The zooids are frequently to be seen inhabiting the same protective sheath. The latter changes to a transparent brown colour with age.

Lagenophrys labiata sp. nov., figs. 17 and 18.

Lorica oval, depressed, the lower or adherent surface plane, the superior or dorsal aspect convex, the posterior margin rounded, the anterior bearing a short, anterior-superior, neck-like prolongation formed of two convex, horizontal and valvular lip-like extensions which open during the protrusion of the ciliary region of the inclosed zooid, and close at the withdrawal of that part, the orifice oval, transversely and superiorly directed; inclosed animalcule frequently filling the entire cavity of the lorica. Length of sheath 1/540 in.; width 1/750 in. Habitat, fresh-water; adherent to the legs and body of *Gammarus* sp.

In fig. 17 is shown the outline in profile of the lorica with separated lips; in figure 18 the same with closed lips.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Embryonic Ganglion-cells.‡—Prof. W. His states that in human embryos, at the conclusion of the first and at the beginning of the second month of development, the cells of the spinal ganglia are bipolar. Of the two processes, that which is dorsally placed passes into the hinder column of the cord, while the ventral makes its way to the motor root-fibres to go still further in a peripheral direction in their company. The processes commence with a conical piece of attachment, but narrow to thin fibres with the character of cylinder-axes. They are not connected with the middle, but with the sides of the cell-body. The nucleus is generally excentric in position, and is succeeded by a more or less broad zone of protoplasm, from the marginal portion of which the two processes pass out in opposite directions. This stage may be regarded as preliminary to the formation of T-shaped fibres. For satisfactory observations at this stage, the ganglion must be free from connective-tissue elements, and have no special investment.

Development of the Mole.§—Mr. W. Heape, in the course of this paper, notes the early appearance of the optic grooves, the formation of the amnion first at the hinder end of the embryo, and the folding off of the head end of the embryo only. Though the optic vesicles begin to appear early, their development is soon checked, doubtless in consequence of the habits of the adult. A complete tube or neurenteric canal becomes developed posteriorly; this is the homologue of the median dorsal diverticulum of the enteron of *Amphioxus*, and it is to be noted that while it there gives rise to the notochord, it almost completely disappears in the mole before the notochord begins to be formed. As, however, the notochord becomes isolated by the ingrowth of the lateral hypoblast below the axial cells, and as it is formed

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

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

‡ Ber. Verhandl. Gesell. Wiss. Leipzig, 1886, p. 290.

§ Quart. Journ. Micr. Sci., xxvii. (1886) pp. 123–63 (3 pls.).

of axial hypoblast cells, there is no reason for doubting the homology of the notochord in these two animals. The mesoblast of the head is not split, and no cavity is formed there. The anus is formed in the middle of the primitive streak. The venous system is very slightly developed, and the blood-corpuscles appear to be formed directly from stellate mesoblast cells.

Influence of the vertical position on the development of the Eggs of the Chick.*—M. C. Dareste finds that when the obtuse pole of the egg is upwards the evolution of the chick is normal, but that this is not the rule when the opposite pole is the upper one. Without offering a complete explanation of these facts, he points out that the "cicatricula" of the egg is in different conditions. Whatever be the position of the egg the yellow is always uppermost, and the cicatricula in the highest part of the yellow. When the narrow pole is the higher the cicatricula is in contact with the shell, from which at one time it is only separated by the vitelline membrane. When the obtuse pole is superior, the cicatricula is in contact with the lower wall of the air-chamber, which has a flexible wall.

Nucleus in Frog's Ovum.†—Dr. G. Thin describes conditions of the nucleus in the ova of *Rana temporaria* between the stages of division into four segments and that of the appearance of the morula condition; sections were made from eggs hardened in bichromate of potash and stained with picrocarmine; these methods were not such as to enable the nuclear network to be satisfactorily made out.

In the first stage observed—or that of a "tablet-nucleus"—an unformed substance was found infiltrating the yolk in certain parts of the segments. Then came the diffuse granular nucleus in which minute yolk tablets were found in the carmine-stained nuclear area; in the homogeneous nucleus the nuclear substance stains homogeneously in carmine, has distinct boundaries, and no yolk tablets or pigment. The fourth stage is that of the shrunk nucleus, in which a crescent-shaped shrivelled homogeneous substance represents the nucleus. Fifthly, simple holes were found which appear to correspond to the position of nuclei. The author gives a short account of the division of the nucleus, of the pigment, and of the pigment in relation to the segment. Pigment has no causal relation in the nuclear changes.

Embryology of Teleostei.‡—Herr H. F. Wenckebach reports the result of some studies on the development of Teleostean embryos, and especially of *Belone*.

1. *The periblast nuclei.*—According to Hoffmann the first segmentation in Teleostei is parallel to the axis of the ovum, and the upper nucleus divides to form the blastoderm, while the lower divides into the free nuclei of the subjacent protoplasmic layer—the periblast. According to Agassiz and Whitman, however, these last nuclei arise from the marginal cells of the blastoderm. Wenckebach's results go to show that the free periblast nuclei always originate from the blastoderm, either (1) from the marginal cells, or (2) from cells which fall from the lower surface of the blastoderm on to the floor of the segmentation cavity, there fusing with the periblast. The author notes the various relative researches of Ryder, Brook, Cunningham, &c., as to the origin and history of the periblast. In relation to the parablast theory of His, Wenckebach notes that as far as the

* Comptes Rendus, ciii. (1886) pp. 696-7.
† Report Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1069-71.
‡ Arch. f. Mikr. Anat., xxviii. (1886) pp. 225-51 (2 pls.).

Teleostei are concerned no nuclei or cells arise in the periblast or in the yolk, and that the nuclei of the periblast, after their separation from the blastoderm, degenerate, and take no direct share in the formation of the embryo.

2. *The development of heart and blood-vessels.*—After the ventral closure of the gut, a band of mesoderm cells is observed close behind the optic vesicles on the lower surface. They arise from the indifferent mesoderm cells of the head which wander round the gut. The mass of cells splits to form a kind of pouch or sac—the incipient heart. He lays special emphasis on the *rôle* of these actively wandering mesoderm cells, not only in forming the heart, but also the vessels and other parts of the embryo. The similarly mesodermic origin of the blood-vessels is noted, and the history of both heart and vessels is briefly discussed. It is important to note that the heart grows as an open bag into the segmentation cavity, and its lumen is nothing else than part of the blastocœl. So too are the three main yolk-vessels parts of the blastocœl. The relation of this fact to Bütschli's theory of the metazoan vascular system, as well as to such points as the blastocœle origin of the proboscis-sheath cavity and vascular system in Nemerteans is briefly noted.

3. In regard to the much disputed *origin of the blood*, Wenckebach maintains at least that it is of purely mesodermic origin, and that neither endoderm nor free periblast nuclei share in its formation.

Relation of Yolk to Blastoderm in Teleostean Fish-ova.*—Mr. G. Brook briefly traces the development of a teleostean ovum from its origin in the germinal epithelium. The excess of nutriment supplied by the follicle is stored up as yolk in small masses. He points out the difference in the relative distribution of protoplasm and yolk in the pelagic group of ova on the one hand, and the herring and others on the other. In *Trachinus*, belonging to the former group, even while segmentation is in progress there is always a thin film of protoplasm around the large single yolk-sphere, and he compares it to a fat-cell. He draws attention to the difference between holoblastic and meroblastic ova, and shows that the real difference is not in the proportion of yolk to protoplasm, but in its distribution; and this necessitates a different mode of assimilation. It is through the agency of the parablast that this takes place, i. e. the portion of the germinal protoplasm which is not included in the germinal disc. So long as there is naked protoplasm around the yolk intracellular digestion can take place, and the protoplasm elaborated from the yolk necessarily takes a share in the formation of the embryo.

Origin of Pigment-cells which invest the Oil-drop of Pelagic Fish-embryos.†—In his examination of the embryos of *Scomber scomber* Mr. J. A. Ryder noticed that before the tail had become prominent pigment-cells began to appear on the side of the oil-drop; around the latter was a layer of protoplasm, continuous with the periblast enveloping the yolk. The periblast is hypoblastic; and the only source of the nuclei of the pigment-cells must be the periblast; therefore these cells are hypoblastic in origin.

Segmentation of Selachian Ovum.‡—In studying the development of Selachia Prof. J. Kollmann observed the persistence of segmentation, at a late stage, on the floor of the segmentation cavity and in the adjacent layer of the yolk. This has been observed by Kupffer in reptiles, and by Gasser in birds. The stages observed were those with oval germinal disc before differentiation of layers, and those with round disc and axial differentiation.

* Proc. R. Phys. Soc. Edinb., ix. (1886) pp. 187-93.
† Amer. Natural., xx. (1886) p. 987.
‡ Verhandl. Naturf. Gesell. Basel, viii. (1886) pp. 103-5.

The cells appeared to Kollmann true segmentation cells. They never arise from yolk-spheres, which are always disintegrated near the embryo. A radial arrangement of the protoplasm round about the nuclei was distinctly observed, and cell-complexes undoubtedly result. They are not undefined elements arising from the yolk or from the primitive lymph of the segmentation cavity.

The yolk-spheres never have nuclei, nor is the yolk penetrated by protoplasmic filaments. They consist simply of nutritive material and are gradually assimilated. Not only the yolk, but all contents of the ovum have to be modified and reconstituted before forming part of the embryo, and on this fact Kollmann lays considerable emphasis.

Ovarian Ovum of the Dipnoi.*—Mr. F. E. Beddard finds in the ovary of *Lepidosiren* two kinds of ova which follow a different course; one is of the ordinary type, the other consists of a number of distinct cells, and appears to have no germinal vesicle; in *Ceratodus* the second kind of ovum is found, but seems to be very rare.

Alternation of Generations in Mammalia.†—In reference to the reproductive relations of *Praopus*, of which a report has already been given,‡ Dr. H. v. Ihering communicates some suggestive notes on alternation of generations. In *Praopus* eight embryos resulted from a single germ, in *Lumbricus trapezoides* a double embryo is constant, in all groups twins may occur from one ovum;—the polar bodies are morphologically nothing less than abortive germs;—in fact, the origin of multiple embryos from a single ovum is the primitive condition, the development of only one is secondary and adaptive. Now if this be pressed to its logical conclusion, one would be forced to the paradoxical conclusion that the *Praopus*, for instance, brings forth grandchildren, and that the mother of twins from one ovum is really their grandmother. The categories are evidently insufficient, and von Ihering proposes the following revised scheme:—

I. Hologenous development (Häckel's hypogenesis). The fertilized ovum developes with or without metamorphosis into a *single individual.*

II. Merogenous development. The fertilized ovum developes into *two or more individuals*, which

(A) return directly to the parent form and mode of reproduction (*Temnogenesis*);

or (B) exhibit an antithesis of diversely reproducing individuals or generations (*Metagenesis, or Alternation of Generations*);

(*a*) *calycogenesis*, in *Salpæ* and *Medusæ*;

(*b*) *pædogenesis*, in *Cecidomyiæ*;

(*c*) *heterogenesis*, in which either both generations reproduce sexually, or one or several multiply parthenogenetically.

Experimental Investigation of Fertilization.§—Prof. R. Hertwig reports some of the results of experiments carried on by himself and his brother Prof. O. Hertwig as to the effect of different reagents on the process of fertilization. The reagent discussed is chloral hydrate; the elements experimented on were those of *Strongylocentrotus lividus.*

* Zool. Anzeig., ix. (1886) pp. 635–7. † Biol. Centralbl., vi. (1886) pp. 532–9.

‡ See this Journal, 1886, p. 765.

§ Anat. Anzeig., i. (1886) pp. 11–16. Cf. also SB. Jenaisch. Gesell. f. Med. u. Naturw., 1886.

(1) Even after accomplished impregnation, the above reagent hinders the normal conjugation of the male and female nuclei. They form division-figures for themselves and divide, but not normally. (2) Maturation and fertilization are associated with fundamental protoplasmic changes. The ovum-nucleus becomes differentiated into fibrils only in the fertilized egg, and the sperm-nucleus in an unripe ovum remains either wholly unchanged or becomes a watery vesicle. Hertwig raises the further questions (*a*) of the possibility of fractional fertilization, and (*b*) as to the actual factors by which the two nuclei are brought together.

Importance of Sexual Reproduction for the Theory of Selection.*—The main aim of Prof. A. Weismann's recent essay on this subject is to establish the position that the process of sexual reproduction is the prime agent by which all the varied differentiations of the complicated phyla of the Metazoa have been brought into existence. It is urged that peculiarities acquired by the parent are not transmitted to the offspring, and that the hypothesis that such acquired peculiarities are transmitted is not necessary for the explanation of the known phenomena of heredity. Characters can only be said to be acquired, the origin of which is due to external influences; if these cannot be transmitted, it is clear that those only can which were present in the germ at the time of its formation. "There are no facts which really prove that acquired characters can be inherited, although many attempts have been made to render such a supposition plausible"; the fact that children of civilized parents, if isolated, show no trace of a language, is cited in this connection. As against the well-known experiments of Brown-Séquard—the hereditarily epileptic guinea-pigs—it is urged that epilepsy is no morphological peculiarity, but a disease. If the epilepsy be due to a microbe, then we can imagine that the microbe might be transmitted with the sperm- or ovi-cell.

The germ-plasma, though immensely complex in its finest structure, has a remarkable power of persistence; as it can remain unchanged it is obvious that it is not easily to be modified. Hereditary individual varieties are to be explained by the fusion of two antithetic germ-cells, or possibly nuclei only; the process of mingling is the cause of the occurrence of hereditarily transmissible individual peculiarities, and it is the production of these peculiarities which it is the office of amphigonic (or sexual) reproduction to effect.

This "startling conclusion" is further elaborated, and is shown to be consistent with a large number of known facts, and accepted generalizations. The author considers that he has plainly shown that the selection theory is by no means incompatible with the conception of the continuity of the germ-plasma, and that he has made sexual reproduction to a certain extent comprehensible.

Chemical Comparison of Male and Female Elements.†—Prof. O. Zacharias has obtained some interesting and suggestive results from the micro-chemical comparison of male and female elements in Characeæ, Mosses, Ferns, Phanerogams, and—Amphibians. In the cases investigated the male cells were distinguished by their small or absent nucleoli and by their rich content of nuclein, while the female elements exhibited a poverty of nuclein, an abundance of albumen, and one or more nucleoli more or less large in proportion. The latter were not distinguishable from the

* Weismann, A., 'Die Bedeutung der Sexuellen Fortpflanzung für die Selektions-Theorie,' 8vo, Jena, 1886. Cf. Prof. H. N. Moseley in 'Nature,' xxxiv. (1886) pp. 629–32.

† Biol. Centralbl., vi. (1886) p. 250 (Ber. 58 Versamml. Deutsch. Naturf Strassburg, 1885).

nucleoli of other nuclei. No nuclein was demonstrable in the protoplasm of the cell. The male cells have in proportion to their mass of protoplasm a larger nuclear mass than the female cells. The fertilized ovum has thus, in proportion to its other contents, more nuclein than the unfertilized. In the unfertilized egg-cell large quantities of nuclein are probably present in extremely fine distribution. In this connection, Strasburger suggests that parthenogenetic ova may be found to be characterized by relative preponderance of nuclein.

Primitive form of Metazoa.*—Prof. W. Salensky contributes an interesting and suggestive discussion of the much debated question as to the nature and origin of the primitive Metazoa. His chief conclusions are summed up as follows:—

1. The primitive form of Metazoa, or more precisely, of the Heteroplastids, may be regarded as a Volvox-like vesicular flagellate colony, nourishing itself in animal fashion, reproducing like a *Volvox*, and exhibiting like it certain individual deviations in its development.

2. From the vesicular primitive form, in the course of the premature liberation of a series of generations, a gastrula results, in which the germinal cells are partly modified into endoderm, and partly persist as they were, so that the primitive genital cavity (genitocœle of Salensky) becomes enteric + genital or a phagogenocœle. This genitogastrula form is provided with an opening.

3. The gut-cavity of the Metazoa is homologous with the brood-cavity or genitocœl of the primitive form. The blastocœl of the Metazoa is a new formation, which only becomes properly developed in the true Metazoa.

4. The blastopore is the homologue of the primitive aperture of the Volvox colony. Its closure is nothing but a reminiscence of the closure of the Volvox aperture.

5. Different forms of blastula are not homologous with one another. Schizoblastulæ are nearest the primitive form. Gastroblastulæ are derived from the primitive type by a process of accelerated differentiation.

β. Histology.†

Studies on the Cell.‡—Herr R. Altmann states that he finds in the cells of animal tissues small bodies, which he calls granules; they only become visible after the tissues have been treated with xylol, alcohol, colouring matter, picric acid, alcohol, bergamot oil, and xylol balsam in succession. The granules are present in large numbers, and appear to increase by division, though it is not certain whether this is the only mode. The author compares them to the lowest organisms, bacteria being, in his opinion, not true cells.

Fundamental Condition of Equilibrium in Living Cells.§—At the moment of formation the cell-membrane of animal and plant cells is thin and plastic, and M. L. Errera points out that it is in the condition of a soap-bubble, and is, like it, so light that the action of gravity may be neglected, and that it arranges itself consequently only under the influence of molecular forces. Admitting this, it is possible to connect the architecture of cells with molecular physics.

* Biol. Centralbl., vi. (1886) pp. 514–25.
† This section is limited to papers relating to Cells and Fibres.
‡ 'Studien über die Zelle,' Heft i., 53 pp. and 1 pl., Leipzig, 1886.
§ Comptes Rendus, ciii. (1886) pp. 822–4.

Physicists have shown that a film of liquid, homogeneous and without weight, can persist only if it forms a surface with a constant mean curvature. Cell-membranes at the time of their formation fulfil this condition. Many of the lower plants (e. g. Conjugatæ) form figures of revolution, either spheres or cylinders, &c.

When a cell divides simultaneously into several others, the collection of partitions forms a "system of laminæ"; and the division of cells in endosperms and sporangia of plants fulfils, very approximately, the condition found in such systems, as to the angles at the junction of the partitions and so on. In the most usual cases of binary division the new partition is nearly at right angles to the old membranes, as Sachs has shown.

In membranes which are not homogeneous the mean curvature, instead of being constant, is at each point in inverse ratio to the tension.

Structure of Glandular Cells.*—Dr. J. H. List sums up his results as to the histology of mucous cells. He notes the distinction between the threadwork and the interfilar substance, the varied arrangement of the former, and the unequal staining of the latter, the independence of the nucleus and its frequently flattened form, &c. As the goblet-cell approaches the surface, and becomes more mature, the threadwork becomes better developed.

In the living cell subtle movement of the threadwork may be detected. The nodes seem slowly to approach one another, and then retreat. List regards as probable the suggestion of Rindfleisch, that the movement was referable to altering adhesion between the two chemically different substances.

During secretion the strands of the threadwork converge towards the mouth, while the transverse connections are for the most part broken. In the plug, expelled and disrupted meshes may be recognized, but the interfilar mass is present in much greater proportion than in the theca. Dr. List therefore suggests that an increase of volume in the interfilar mass may be the main factor in the secretion, while the threadwork remains more passive. In regard to the proportion between cell protoplasm and secreted substance, the author found that the former was completely modified at an early stage.

Goblet-cells.†—Dr. J. H. List gives a detailed account of his researches on goblet-cells. The memoir is introduced by a full historical critique of relative observation.

In describing the *form* of goblet-cells, Dr. List distinguishes those without a basal process or foot containing the nucleus, and those with such an appendage to the "theca" or body of the cell. The former are again distinguished into stalked and unstalked forms. The various sizes in different regions and organisms are tabulated.

The *content* of the theca consists of a framework, with polygonal or round meshes, and a homogeneous substance, less readily stainable, occupying the meshes. The former is distinguished as the threadwork ("Filarmasse") and the other as the "interfilary" substance. Both are described in detail. The contents of the foot are similar. The stalk appears homogeneous and sometimes granular. The author was unable to see any connection between the network of the cell and the intranuclear network. The characters of the nuclei in the different forms are described, karyokinetic figures were never observed, but multinuclear cells occurred.

* Biol. Centralbl., vi. (1886) pp. 592–6 (Ber. 59 Versamml. Deutsch. Naturf., Berlin, 1886).

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 481–588 (6 pls.).

The *secretion* occurs normally in superficial cells in which a stoma has been formed as the result of pressure and absorption. The secretion is apparently determined by what appears like a gradual coagulation. No nuclear modifications were observed. The secreted mass consists chiefly of the interfilary substance, but the threadwork was also represented. The secretion may be repeated more than once, but finally the whole cell is expelled. This degeneration is associated with epithelial regeneration, and even still functional cells may be expelled.

In regard to the *development* of the goblet-cells, Dr. List's results go to show that they are modified from epithelial cells of the subjacent layers. The very varied occurrence of the cells is then discussed. The author maintains the entire distinctness of the goblet-cell types, and the distinctions which he draws between them and Leydig's cells have already been noted in this Journal. He differs from Schiefferdecker in maintaining further their entire distinctness from the cells of mucous glands.

Some interesting facts are communicated in regard to the artificial production of goblet-like cells by the action of reagents upon ordinary epithelial cells. As to the physiological import of the cells, about which there has been so much variety of opinion, the author only commits himself to regarding them as unicellular glands of a perfectly specific character. The action of various reagents is finally noted.

Endogenous Cell-multiplication.*—M. A. Jaworowski has investigated the development and histogenesis of *Chironomus* and other organisms with special reference to the endogenous multiplication of cells.

I. (*a*) *The reproductive organs of Chironomus* arise dorsally on the ninth ring in the form of a protoplasmic mass composed of two cells and surrounded by a fine homogeneous membrane. Within each of these two cells four daughter-cells arise, and the endogenous method of multiplication is constant. Each ovarian tube is primitively spherical; it elongates gradually by the formation of new cells at the anterior pole, and is successively constricted at the limit of each new centre of development. The thread-like tube which results contains protoplasm and cells which give rise to the terminal filament of the ovarian tube. The centre of each constriction is occupied by a cell increasing at the expense of its neighbours and forming the ovum. The author maintains that the ovarian tubes of vertebrates are similarly formed.

(*b*) *Muscular sheath of the ovarian tubes.*—Among the mother-cells which give rise to the ovarian tubes there is a portion of residual protoplasm of the primitive cell. This always forms little nucleated cells which become muscle-fibres. These elongate in all directions, and form a single-layered muscular network round the ovarian tubes.

(*c*) *The terminal filaments and the efferent ducts* are then described, without, however, establishing much that is new. From a single primitive cell, according to Jaworowski, the entire organ arises. All the cells—ovules, epithelial, and vitelline—are homologous. The latter never serve to nourish the ovules except in a wholly indirect way.

(*d*) *The egg-envelope* is not due to peripheral ovules or epithelial cells, but solely to the surrounding protoplasm of the primitive cells. The epithelial cells only form markings on the envelope. The author, in concluding his detailed survey of the development of the reproductive organs, refers the *rapid death* of the insects after egg-laying or sperm emission to the fact that the abdominal cavity, distended with reproductive elements, cannot retract immediately after the expulsion of the latter, and

* Arch. Slav. de Biol., i. (1886) pp. 641–51, from Ann. Acad. Sci. Cracovie, 1885.

becomes replete with blood which cannot re-enter the circulation. The *pædogenesis* M. Jaworowski refers to the rupture of the incompletely developed ovarian membrane, and the liberation of ovules into the body-cavity, where amid richly nutritive environment, they are able to develope into larvæ without fertilization.

II. The author next describes the development of the vascular system in the chick, &c. His results differ considerably from those generally accepted. The cells of the mesoderm are not distinctly separate, but bathed in protoplasm. Some of them, instead of dividing and separating, form multicellular endogenous vesicles. The protoplasm of the peripheral layer collects at certain points and forms pseudopodia, which penetrate among the other mesoderm cells. One of these processes becomes united with that of an adjacent vesicle; the others disappear. Meanwhile the daughter-cells of the vesicle are being arranged, some peripherally in the protoplasm, and others centrally. The former become elongated, flattened, and connected to form the walls; the latter form the blood elements. The development of the heart is essentially similar.

He sums up his conclusions as follows:—(1) That the membrane of mesoderm cells is primitively formed of a network of ramified cells, multiplying and elongating in all directions, and finally flattening out to form an apparently homogeneous membrane; (2) that the nucleus is a daughter-cell, or rather a vesicle with walls composed of granulations bound together by fundamental filaments; (3) that the nucleolus is a vesicle, and formed as a protoplasmic granule within another vesicle or developing cell, viz. the nucleus; and (4) that the protoplasm of the cell is the only formative and nutritive substance of these granules, which are in fact cell-germs. The division of the nucleus is only apparent. All nuclei arise as granules in the fundamental protoplasm.

III. *Blood in the adult organism.*—M. Jaworowski finds the same way of looking at cells and nuclei verified further in the blood of adult animals. The serum is the creative and fundamental substance. In it are developed the white corpuscles, which losing their nuclei and becoming granular form mother-cells, of which the daughter-cells may either become red blood-corpuscles or their mother-cells. The white corpuscles are mostly formed in the lymphatic system, and the author does not distinguish them from lymph cells. The mother-cells break up into daughter-cells especially under the pressure of the capillary walls. Various other questions are discussed.

IV. *Development of striped muscle.*—M. Jaworowski has studied the endogenous multiplication of cells in the developing striped muscles of fish embryos (*Alburnus*). The least developed muscular mass consisted of elongated cells surrounded by a membrane containing one or more daughter-cells, some of which are already transformed into mother-cells of the second order. He believes that an elongated primitive cell forms the entire muscle, but it is difficult to give a brief elucidation of the process; nor is one much encouraged to attempt this till the close of the memoir affords more definite information as to what M. Jaworowski means by the words vesicle, cell, and nucleus.

Cilia.*—Herr J. Frenzel has studied the histology of cilia in a considerable number of living forms, with the general result of demonstrating their complicated structure. He gives a brief historical note of the principal researches since Engelmann's classic memoir.

In many instances Herr Frenzel observed that the "basal portions"

* Arch. f. Mikr. Anat., xxviii. (1886) pp. 53–80 (1 pl.).

(" Fuss-stücke) were simple uniform rods, but provided both at their upper and lower end with a sharply defined apparently spherical knob. Viewed from the side, a row of these basal portions thus forms two parallel pearl-necklace-like lines. This has been repeatedly described as a double-contoured cuticle, which it certainly very closely resembles when the knobs are closely packed together. Modifications are not unfrequent, such as the disappearance of one or both rows of knobs. Or, again, two distinct lower rows of knobs may be present. Herr Frenzel confirms the general opinion that the cilia are continuations of the basal rods. A connecting portion, a bulb, and a lash proper were distinguishable in the cilium, but not always. In some cases eight parts might be distinguished, (1) a basal knob next the cell, (2) an inferior clot, (3) an accessory inferior knob, (4) the basal rod itself, (5) the superior knob, (6) the connecting portion, (7) the hair-bulb, (8) the shaft. These results are compared with what is otherwise known of cuticular fringes and the like. All these structures, basal rods among the rest, Frenzel regards as protections for the sensitive and otherwise naked cell.

Formation of Vacuoles in red-blood Corpuscles.*—Herr W. Nikolsky has treated blood-corpuscles with ammonium chlorate and other ammonium compounds with the following results:—(1) It seems very probable that by treatment with ammonium chlorate, &c., vacuoles may be produced in the blood-corpuscles of all animals with nucleated red corpuscles. (2) It is probable, further, that vacuoles in other cells, as described by several authorities, may have a similar origin. (3) His result points to the gaseous nature of the vacuoles. It may be ammonia or a derivative of ammonia with an organic radical. The vacuoles grow smaller and finally disappear on treatment with much chlorate of ammonium. The fact that the vacuoles disappear under the influence of acids, confirms the supposition of the basic nature of these gas bubbles.

Wandering Leucocytes in Epithelium.†—Dr. J. H. List describes the morphology of wandering leucocytes which he studied in the cloacal epithelium of *Raja miraletus*. The refractive, homogeneous or slightly granular, nucleated and vacuolated cells, varied greatly in form and size. They are very closely associated with the epithelial, round which they sometimes form a ring. In cavities between the epithelial cells a number of leucocytes were occasionally observed. Small bodies like portions of leucocytes were frequently seen. It seems possible that the leucocytes are destroyed in their migration through the epithelium.

Genesis and Death of Muscle-fibre.‡—Dr. T. G. Navalichin has studied the genesis and death of the muscles of the eye in a number of vertebrates.

The muscles of newly killed animals were put for some weeks in water slightly acidified with acetic acid. The normal union between the muscle-fibres and the tendinous strands was thus preserved intact. The following results were obtained:—(1) In the muscles of the eye, especially in young forms, the fibres are surrounded by sheaths of sarcolemma open at the ends of the fibre. The component fibrils pass by fine terminal ends into the fibrils of the tendon. (2) Among the primitive strands of the tendinous tissue, there are rows of elongated, fusiform, transparent elements, with one nucleus, or occasionally with two. These elements are connected together by fine terminal threads. In contact with the muscular tissue, however, these prolongations unite into fibrils, which project outside the gaping ends

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 437–41 (1 fig.).
† Ibid., xxviii. (1886) pp. 251–6 (1 pl.). ‡ Arch. Slav. de Biol., i. (1886) pp. 134–8

of the sarcolemma sheaths. These "myoplasts" are observed in the tissue of the external perimysium, chiefly among the muscle-bundles. As to their origin, they may be derived from the elements of the osteogenic layer of the periosteum, or perhaps from the so-called formative or plasmatic cells. (3) Among the tendinous strands and in the tissue of the external perimysium, very thin (1–2 μ) muscle-fibrils are observed. Their origin from the modification of the above myoplasts is described. The young fibre has a sheath of sarcolemma, and this seems capable of growth. The muscular fibre grows at either pole by means of new myoplasts, which become terminally connected with the muscle-fibrils. (4) This account of the origin of muscle-fibres confirms physiologically the correctness of the morphological division of fibres into fibrils. (5) The author believes that the regeneration of destroyed muscle is also effected through myoplasts. (6) Beside the normal fibres, he observed sarcolemma sheaths filled with an unstriated, more or less opaque mass. The mass contained round or oval elements, and one nucleus, or sometimes two. The muscular substance was only represented by the slightest traces. These elements correspond to the "Muskelzellenschläuche" of Waldeyer or to the "Wanderzellenschläuche" of Erbkam.

Seeking to discover the nature of these peculiar sarcolemma sheaths, the author proceeded to follow a method recommended by Rachmanmow. The limb of a young animal was ligatured for 10–12 hours by means of an indiarubber band. In animals killed within 24 hours after the removal of the ligature, it was seen that the myoplasts nearest the end of an adult fibre had not exhibited the modifications which, as above noted, serve for the increase of the muscle substance. On the contrary, the change in their nutritive relations brought about by the pressure had induced peculiar transformations. The nucleus had disappeared, the protoplasm was granular and had divided into five or six masses. The author believes that these myoplasts destroy the muscle, penetrating into the sarcolemma sheath and into the mass of the fibre, and in the abundant nutrition proliferating rapidly. (7) The "Muskelzellenschläuche" and "Wanderzellenschläuche" of other authors are these "myoplasts."

γ. General.*

Colour-sense.†—Herr Tiebe gives a useful historical account of the more important researches on the perception of colour and brightness by animals. He devotes most attention to the recent researches of Prof. Graber, who demonstrated over a wide series of forms sensitiveness to differences of colour and brightness.

Influence of Electric Currents on Tadpoles.‡—Herr L. Hermann has continued his curious experiments on the behaviour of tadpoles in a vessel through which an electric current was allowed to pass. They dispose themselves in such circumstances with their head towards the anode. He proved that this depended on the nervous rather than upon the muscular system, and was only exhibited, for instance, by portions of tadpoles containing part of the spinal cord. The experiments were varied in different ways, e. g. by inserting one of the electrodes in the immediate neighbourhood of head or tail. The result was always the same, that the ascending current produced lively movements and unrest, while the descending

* This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

† Biol. Centralbl., vi. (1886) pp. 489–503.

‡ Arch. f. d. gesammt. Physiol. (Pflüger), xxxix. (1886) pp. 414–9.

current produced quietness or, at a maximum, paralysis. Herr Hermann does not yet attempt to draw any general conclusion from his results. He notes in a postscript the clear and almost transparent appearance of the larvæ after even a short darkness, and further the presence of air in the rudimentary lungs, while the alimentary tube never contained any.

B. INVERTEBRATA.*

Minimum Temperature consistent with Life.†—In a series of experiments on about two dozen worms, Arthropods, and Molluscs, Dr. H. Roedel has extended Pouchet's well-known researches as to the resistance of animals to cold. His general results are as follows:—

1. Lower animals become frozen at temperatures varying greatly in the different genera and species. The resistance varies with the actual body-heat of the animal, with its size, structure, and protective covering, with the freezing-point of the blood, &c.

2. The resistance usually increases with progressive development, but sometimes the adults are more sensitive than the young.

3. Nothing can be directly inferred from the geographical distribution.

4. Perfectly frozen animals are never revivified.

He proposes a curve with the degree and the duration of the temperature as co-ordinates. These two factors must be considered together. The absolute minimum is obviously the fatal temperature in unit time. He enumerates the various results as exhibited by degeneration, cessation of certain functions, sleep-like paralysis, and death; and sums up his experiments in a tabular survey.

New Function for Invertebrate Otocysts.‡—M. Y. Delage has made a series of experiments on *Sepia* and some Crustacea (*Mysis*, *Palæmon*, and *Polybius*), in order to ascertain the effect produced on their powers of swimming by the removal of the eyes and otocysts.

He finds that the removal of the eye does not inconvenience the animal to any great extent; it will continue to swim in the ordinary way, but rather more slowly; it does not turn over on its dorsal surface, and keeps straight on its course. But on the removal of the otocyst, either with or without the eye, its course is no longer direct, but the animal turns on its axis, performs somersaults, and in fact completely loses control of its actions.

The author therefore concludes that the presence of otocysts, hitherto regarded only as auditory organs, is necessary for regulating the animal's locomotion. He points out the resemblance between his own results and those of Fleurens on rabbits and pigeons.

Function of the Malpighian Tubes of Insects and Nephridium of Pulmonate Mollusca.§—Dr. C. A. MacMunn has obtained uric acid crystals from these organs, establishing that the view held that they function like the kidney of vertebrates is well founded.

Pelagic Microzoa of the Baltic.‖—Dr. O. E. Imhof, from observations made at four stations in the Baltic, is able to confirm the view of Pouchet and de Guerne as to the connection between the pelagic fauna of the

* When a paper deals with the subjects of more than one of the following divisions it is placed here.

† Zeitschr. f. Naturwiss., lix. (1886) pp. 183–214.

‡ Comptes Rendus, ciii. (1886) pp. 798–800.

§ Journ. of Physiol., vii. (1886) pp. 128–9. See extended notice, *infra*, Microscopy β.

‖ Zool. Anzeig., ix. (1886) pp. 612–5.

Baltic and that of German (? Swiss) fresh-water lakes; of course, however, there are some species in the Baltic which are not, so far as is known, in the lakes also.

Microscopic Organisms in Fresh Water.*—Dr. G. Asper, in investigating the pelagic fauna of fresh-water lakes, finds that the most abundant forms in Lake Zurich are *Ceratium*, *Dinobryon*, *Volvox*, *Vorticella*, *Anurea*, *Polyarthra*, and *Synchæta*. The Protozoa and Rotifera considerably exceed in numbers the Entomostraca; and of the above forms, one genus will be predominant at one time, whilst at another time some other genus will exceed it in numbers. Pelagic species of *Difflugia*, and rich development of diatoms, especially *Asterionella formosa*, were also found.

Amphibious Life in Rhizomorpha.†—Dr. R. Schneider has made an investigation into the animals found living amongst the mycelia of *Rhizomorpha subterranea* in a damp grotto near Dresden; he found 51 forms, 24 of which are Protozoa, 8 Vermes, 18 Arthropoda, and 1 Mollusc; of these 30 are typically aquatic, 14 terrestrial, and 7 amphibious.

Mollusca.

Eyes of Mollusca.‡—Mr. W. Patten communicates the results of his investigation of the eyes of Molluscs (and Arthropods §). His results differ widely from those of Grenacher and other authorities, and lead to the reduction of the essential parts of all visual organs to one structural plan, which can be followed throughout the whole animal kingdom. Some difference of opinion exists as to the author's views.‖

1. *Arca.*—The eyes of the timid *Arcas*, which detect even a faint shadow cast on the water, are of three kinds—facetted, invaginate, and pseudo-lenticulate. The first are aggregate, and are confined to the anterior and posterior thickenings of the mantle edge. The invaginate eyes, forming oval pigmented cups, are smaller than the latter, and form a narrow band along the summit of that portion of the ophthalmic fold of the mantle margin, beneath the ventral opening in the shell through which the byssus projects. The third form resembles the last type, but is not invaginated, and consists of a few retinal cells, covered with a lenticular and refractive body like a cornea, or lens. They occur irregularly among the invaginate forms. There are altogether about 1300 eyes for each individual.

After a brief historical review, Patten proceeds to describe the structure of the compound eyes. They consist of 10–80 "ommatidia." Each wedge-shaped ommatidium consists of a central core of two fused cells (*retinophoræ*), whose bases are directed outward, and support a double, highly refractile rod or perceptive element. The central cells (or *retinophoræ*) are surrounded by two rows of four pigmented cover cells (or *retinulæ*). The outer end of each of these is capped by a thick layer of transparent and perfectly homogeneous cuticula. The inner, membranous prolongations consist of flattened, and longitudinally striated "*bacilli*," ending abruptly in root-like fibres. The expanded pigmented cells form a broad collar for the *retinophoræ*. The connection of the nerve-fibres with the pigment cells, and with the *retinophoræ* is then noted. A special aggregation of fibres can be seen passing along the outer surface of the latter, and they also inclose, being double, a centre bundle.

The invaginate eyes are simple thickened portions of the hypodermis,

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 366–7.
† SB. Preuss. Akad. Wiss., xxxix. (1886) pp. 883–900 (1 pl.).
‡ MT. Zool. Stat. Neapel, vi. pp. 542–756 (5 pls.). § Cf. *infra*, p. 82.
‖ See Prof. E. R. Lankester in Quart. Journ. Micr. Sci., xxvii. (1886) pp. 285–92.

sunk below the surface, forming shallow depressions or deep funnel-like pits. The eyes are each composed of the same elements as the facetted, that is, a central colourless cell, probably containing an axial nerve-fibre and two nuclei, together with a cuticular rod supporting a specialized part of the retia terminalia (the retinidium); around each of these central cells, or retinophoræ, are arranged a number of pigmented ones—in this case more than a single circle—which also support nerve-bearing cuticular rods. Each eye is described as a *retineum*, i. e. a collection of ommatidia in which the retinidia (or rods) of both retinulæ and retinophoræ, or of the latter alone, form a continuous layer, the retinulæ retaining their pigment and primitive arrangement around the retinophoræ.

The *pseudo-lenticulate eyes* are transitional. They occur as sharply defined groups of non-invaginated ommatidia, provided with a prominent lenticular thickening of the cuticula, containing nerve-fibres. A retinal cuticula is formed by the pigmented cover-cells, as well as by the retinophoræ, and hence these eyes resemble more closely the invaginated forms; on the other hand, they tend to form a protuberant convex surface, instead of a concave one.

2. After a brief notice of *Pectunculus*, Mr. Patten proceeds to the discussion of the eyes of *Pecten*. First, in regard to the general structure and function, he shows that the parts really have the function that their names and composition suggest. The movements of lens and iris are described. That the lens is really such was proved by observing the formation of perfect inverted images in the depths of the eye. They are formed by the cornea and surface of the lens, as upright and reflected images. The image falls upon the percipient rods just above the tapetum. By focusing between the argentea and the place where the image formed by the lens is seen with the greatest advantage, a double image is seen, less distinct towards the argentea, but increasing in sharpness towards the focal point of the eye, where the two images ultimately fuse to form a single one. The only explanation he has to offer for the origin of this second image, is that it is a reflected one of the first, formed by the curved surface of the argentea.

The distribution of the eyes is then considered, and an attempt made to explain the differences, e. g. between the two sides of the mantle. In those species in which the eyes are especially numerous, a number of eyes occur in which the pupils are entirely covered with pigment, but the retina nevertheless perfectly developed. (*a*) The whole *external surface* of the eye is covered with a continuous layer of columnar epithelium, increasing in height as far as the iris, where it is suddenly reduced in thickness, and losing its pigment forms the cornea. (*b*) The *corneal cells* are columnar, capped externally with cuticula, and interlocked with one another by irregular folds. (*c*) The cells of *iris* only differ from those of the cornea in being larger and filled with pigment. They serve merely to exclude the lateral rays of light from the retina. (*d*) The *stalk* consists of loose connective tissue containing enormous blood-spaces. Two groups of long striated muscle cells act as erectors and depressors. Anteriorly, they are replaced by numerous fine fibres forming a hyaline "*pseudo-cornea*" just beneath the cornea. At the edge of the iris, many fibres appear to terminate in an outward curve, as though attached to the epithelium at that point, forming the "*ciliaris*." (*e*) The *lens*, which is suspended in a large blood-sinus, consists of a modified group of mesoderm cells, continuous with those of the pseudo-cornea and connective tissue capsule. Its minute structure, and the formation of the membrane called the *suspensory ligament* are then discussed.

The lens and the corneas form the anterior, dioptric part of the eye. The posterior portion is a thick concave disc, completely inclosed in a membranous "*ommateal*" sac. The anterior wall or *septal membrane* protects the ends of the retinal cells and forms an elastic cushion for the lens. The still thicker inner wall forms the tough double *sclerotica*. The cells within the sac form a closed vesicle with obliterated central cavity. The originally simple wall consists of four layers,—(*a*) anteriorly, an outer ganglionic layer, an inner ganglionic layer, the retinophoræ, and the rods containing the retinidia, and (*b*) posteriorly, an outer vitreous network, a double argentea, and the red tapetum. (1) The *retinophoræ* form the largest and most important layer of the retina. Their outer ends, narrowed to nerve-fibres, are attached to the periphery of the retina, whence they are directed inwards towards the optic axis. Their structure and disposition is described. A delicate structureless wall separates the retinophoræ from their rods. (2) The *rods* are columnar bodies of a faint yellowish-red colour. They consist of a hyaline, refractive cap, surrounding a pyramidal core, filled with a watery, non-refractive fluid. The course of the axial nerve-fibre of the retinophoræ, and the disposition of the radiating fibrillæ which form the greater part of the rods, are then noted. (3, 4) Two other groups of cells, the *inner and the outer ganglionic layers*, add to the complication of the outer wall of the optic vesicle. The four strata are modifications of a single layer.

As to the inner wall, (1) the *vitreous network* has hitherto been overlooked. It is a very thin layer of hyaline substance, perforated by large holes in which the inner ends of the rods fit. It is a cuticular secretion of the outer layer of the argentea, and homologous with the cuticular rods secreted by the retinophoræ. (2, 3) The *argentea* is formed by the modification of two cell-layers into refractive, laminated membranes, each composed of minute square plates with bevelled edges. It is thicker in the centre of the eye, gradually diminishing peripherally to a thin layer. "While acting as a perfect reflector for incident rays passing through the lens, it offers no great impediment to the entrance of light into the retina, after passing through the colourless eye-stalk and red tapetum." (4) The *tapetum* or "red pigment layer" consists of a single layer of cells, decreasing in thickness peripherally, and ending with the argentea, where the fibres from the axial branch of the optic nerve enter the retina.

The optic vesicle, with the above eight layers, is contained in the ommateal sac. The anterior wall or *septum* of the latter forms a stout double membrane on which the lens rests. The inner wall or *sclerotica* consists of tough hyaline connective tissue, decreasing in thickness to the periphery of the retina, where it becomes continuous with the septal membrane. It is also a double layer.

The *optic nerve*, which arises from the circumpallial, extends through the centre of the stalk, and divides into two nearly equal branches. "The basal or axial branch abuts against the sclerotica, and losing its sheath, divides into many bundles of free nerve-fibres, which, clinging closely to the sclerotica, ascend radially towards the periphery of the retina, where they penetrate, in quite distinct groups, the ommateal membrane, and become continuous with the attenuated ends of the retinophoræ, through the centre of which they are extended as axial nerve-fibres. The lateral or ganglionic branch ascends towards the shell side of the retina, over which it is bent nearly at right angles, and is continued over the surface of the septum, the thick outer layer of which it penetrates just below the inner surface of the lens. Its fibres unite with the ganglionic layers, or pass between their cells to the surface of the rods."

An account is then given of the *development* of the eye in *Pecten*. *Inter alia*, Mr. Patten notes the occurrence of transitory pigmented cups, probably homologous with the invaginated eyes of *Arca*. At the base of the ophthalmic fold, between it and the velum, a few large cells form small oval thickenings, the rudiments of the future eye. By continued proliferation of the cells on the outer side of the optic thickening an oval knob-like papilla is formed. The proliferation continues to form a hypodermic core. At first this is not sharply defined, and several of the deeper cells separate from the rest and mingle with the numerous connective-tissue cells. They are the ganglionic cells, which later provide the eye with nerve-fibres. The optic vesicle and several of its parts are then accounted for in detail. An interesting comparison between the origin of the sense-papillæ and the origin of the optic nerves is suggested, and a future elaboration promised. The sense-hair papillæ appear as thickenings of the hypodermis similar to those of the eyes. An inward proliferation of cells forms an ectodermic core, which becomes transformed into the longitudinal nerve with which every tentacle is provided.

Patten's observations are then extended to *Ostrea*, *Mactra*, *Pinna*, *Avicula*, *Cardium*, and *Haliotis*. The chapter on Arthropods is reported on separately.* Some of his suggestive conclusions on Mollusca are summarized below.

General.—The term ommatidium is redefined by Patten to designate those constructive elements of all eyes consisting of single (?) or compound colourless cells—the retinophoræ, surrounded by one or more circles of pigmented ones, or retinulæ. A typical molluscan ommatidium consists of a double, colourless, sometimes gland-like cell, the retinophora, containing two nuclei and an axial nerve-fibre. The external surface of the latter contains nerve-fibres, breaking up externally into fibrillæ continuous with those from the axial nerve, and forming a network or retinidium, usually supported by a cuticular secretion or rod. The pigmented cells round the retinophora may also exhibit retia terminalia in a cuticular secretion.

The visual organs of Molluscs are referable to four types; the diffuse, the invaginate, the facetted, and the pseudo-lenticulate, representing the three modifications of light-sensitive surfaces, i. e. a retineum, an ommateum, and a retina. (An ingenious comparison is made between the chromatophores of Cephalopoda and the isolated ommatidia.) The relation of these four types is shown, the invaginate have originated from the pigmented pits, and the facetted from the invaginate form. The frequent presence of an unnecessary number of eyes is explained by the hypothesis that eyes originated from organs having other functions, viz. from organs for the absorption of energy from the sunlight, or *heliophags*.

The high epithelial cells of Molluscs end at the base in several root-fibres attached to the basal membrane, and are frequently pigmented externally and capped by a double cuticula. In nearly all nerve-fibres extend along the wall of the cells towards their outer ends. A rete terminale is present throughout the whole hypodermis, and especially well developed near the eyes. In some cases large unbranching nerve-fibres pass directly to the cuticle, and seem to end in sense-hairs. These large fibres expand below the basal membrane into nucleated bipolar vesicles. This basal expansion wanders into the underlying tissue, while the outer end becomes educed to fibre, but still terminates into one or more sense-hairs. The outer end gives rise to minute cross fibrillæ which unite with others, the tuft of hairs disappears, and *the sense-cell has become a bipolar ganglionic*

* *Infra*, p. 82.

one. The body gives off secondary fibres which unite with those from other cells, and the bipolar becomes a multipolar cell. "In no case do nerves from the central system unite directly with the sense-cells. All the nerve-endings in the hypodermis mark approximately the places where the ganglionic cells originated. The latter alone are directly united on the one hand with the hypodermis, and on the other with the central nervous system. The nerves must thus terminate between cells, and probably extend to their very outer ends." Sense-cells occur, however, apparently terminating in a single fibre, which does not extend along the walls. In this connection Patten notes that while the ordinary epithelial cells which by their root-fibres form the basal membrane, probably homologous with myo-epithelial cells of Cœlenterates, the sense-hair cells, which terminate in a single fibre, are homologous with the neuro-epithelial cells. The inward prolongations of the sense-cells in the Mollusca are not then nerve-fibres, arising either from the nervous system or from peripheral ganglionic cells, but are simply nervous prolongations of the sense-cells themselves, and are probably united at their inner ends with a contractile one which originated near the sense-cell, and which during its inward growth has drawn the nervous fibre of the latter after it. The sense-cells have intercellular nerve-fibres like the ordinary epithelial cells. The central nervous system arose like the peripheral ganglion cells. As the ganglion cells of a single sense-organ became connected, similarly do the ganglia of remote sense-organs become connected with the central system. In the origin of a sense-organ from a group of hypodermic cells, the increase of nerve-cells is associated with increasing sensitiveness, and finally gives rise to a subjacent layer of ganglion-cells united on the one hand with the central nervous system, and the other with the sensitive cells, between which the ganglionic ones have arisen. We find abundant transitions between sensory and ganglionic cells.

"Liver" of Mollusca.*—In this communication on the so-called liver of the Mollusca Dr. J. Frenzel reports that he has made a histological examination of a number of species; in the Cephalopoda, and probably also in some Prosobranchiata, there is only one kind of epithelial cell, which is comparable to the club-shaped ferment-cells of other molluscs; in these forms the "liver" must be regarded as a digestive gland. In a number of Prosobranchiata the epithelial cells are of the granular character, and here, on Barfurth's showing, the organ must be considered to be a true liver. In the Opisthobranchiata the gland has two kinds of secreting elements, and may, therefore, be a "hepatopancreas."

As, notwithstanding all their differences, the livers of Mollusca have so many histological details in common, the author thinks the organ must have a common function; the suggestion of Barfurth that it gives rise to glycogen seems to be disposed of by the answer that glycogen is especially found in young, developing cells, and that such cells are always to be found in abundance in the molluscan liver. It is well to retain for the organ the name of midgut gland.

Nervous System of Gastropoda.†—Prof. H. de Lacaze-Duthiers points out that in studying the nervous system of Mollusca we ought to seek to recognize the primary so as to distinguish them from the secondary ganglia. This may be illustrated by the innervation of the digestive tube of some of the Gastropoda. Here the origin of the cerebrosympathetic connectives

* Boll. Soc. Adriat. Sci. Nat. Trieste, ix. (1886) pp. 226–39.
† Comptes Rendus, ciii. (1886) pp. 583–7.

on the anterior and superior face of the cerebral ganglia, and the presence of two always symmetrical ganglia at the angle made between the œsophagus and the lingual pouch are constant phenomena; these two ganglia form the stomatogastric centre, and give off a definite system of nerves. When the masticatory apparatus is robust and is moved by powerful muscles a series of small ganglionic centres make their appearance. The author describes the different arrangements which obtain in various gastropods, in which parts of the digestive tract are specially modified, and he points out that the corresponding modifications in the nervous supply must not be thought to in any way modify the interpretation of the stomatogastric centre, which always remains the same in its central part, and is only modified in a part of its periphery to respond to new wants.

Development of Genital Apparatus of Stylommatophorous Pulmonata.*—Dr. J. Brock finds the first rudiment of the generative organs of Stylommatophorous Pulmonata in larvæ just previous to extrusion; at the side of the right central ganglion, in a shallow depression, there lay directly beneath the cutis a fine cord of cells with a distinct lumen; posteriorly, the duct took a somewhat upward direction, and lay by the outer lower angle of the central ganglia. The wall of this primary genital duct consists of a layer of radially arranged cubical cells. It is to be noted that it is to be found on the right side only. This appears to be the structure which Rouzeaud calls the "bourgeon primitif," but Brock knows of no fact which would justify an ascription to it of an ectodermal origin.

The next stage studied was found in free forms, about 2 mm. long; the primary duct is longer, and the hermaphrodite gland is beginning to be formed; the first rudiment of the penis is found in a spindle-shaped outgrowth, while a thickening of the median wall is the earliest indication of the dart-sac; the hermaphrodite duct is also beginning to be formed. The author thinks the evidence that in the Pulmonata, at any rate, the whole of the generative apparatus is derived from the mesoblast, is complete.

In somewhat older animals the genital duct and the hermaphrodite gland become connected by the hermaphrodite duct, the whole of this appearing at almost the same time; it is important to note that in the Pulmonata the germ-gland and the efferent duct were primitively separate. The other changes that occur in this stage are increase in length of the duct and of the rudimentary penis; the outgrowing of the penis results in the appearance of the distally placed genital atrium. In specimens hardly any older the penial swelling becomes constricted off from the primary genital duct as a blind sac, and the hermaphrodite gland begins to be broken up into lobules. The constriction of the penis goes on rapidly, and the organ becomes greatly increased in size.

In animals 4–5 mm. long three important changes take place; these are the development of the vas deferens as an outgrowth of the penial blind sac, the division of the primary genital duct into a male and a female duct, and the breaking through of the outer genital orifice; there is no evidence at all to support the supposition that an ectodermal invagination takes any part in the formation of this orifice. The penis is now completely constricted off from the primary genital cord, and the atrium also becomes distinct. The hermaphrodite gland becomes more lobulated, and elements are developed in it which may be regarded as primitive ova; these are large rounded cells with a large round nucleus and a large nucleolus.

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 333–95 (4 pls.).

The next set of changes, which occur in animals 7–9 mm. long, give the generative organs their definite form; the primary duct continues to divide into two, and is continued distally into the penis, so that now the male and female ducts arise directly from the cavity of the penis. The small outgrowth at the base of the penis, in which may be recognized the rudiment of the vas deferens, increases in height, against the side of the female duct, into which it opens when the walls at the point of junction become absorbed. The flagellum appears as a blind diverticulum which arises at the base of the penis; at its blind end two secondary cæcal vesicles early become apparent. The prostate glands are developed as small outgrowths of the female duct proximal to the connection with the vas deferens. The rudiment of the receptaculum seminis was first seen in an animal about 12 mm. long, where it appeared as a short wide-necked outgrowth of the penis; it arises just below the orifice of the atrium.

We may note the following general considerations as results of this investigation; the portion of the duct which is temporarily separated off alone appears to be the homologue of the male ducts of the most closely allied forms in which there are separate efferent ducts; the single genital orifice is the homologue of the female orifice of the Basommatophora, while the male orifice is only a secondary product of the penis; the seminal groove and the prostate glands of the Stylommatophora are a product of the female duct; the anatomical relations of the ducts of the Stylommatophora must not be derived from that of the Basommatophora by supposing that there has been a secondary fusion of the two ducts. The generative apparatus of the Basommatophora may be derived from that of the Stylommatophora, but the converse proposition is not permissible. There can be no doubt that the penis and vas deferens are neomorphs, developed within the limits of the phylum of the Pulmonata.

When we extend our survey to another group of Gastropod Molluscs, we find we are justified in saying that the permanent disposition of the generative organs of the Prosobranchiata is temporary in the Pulmonata. The latter are laid down and developed on the female type, and only become hermaphrodite by the late appearance of modifications, which are, developmentally, unessential; when purely female forms are seen we must not explain the phenomenon by regarding it as atavistic, but simply as a more forcible marking of the female type which is normally predominant in development. The author reminds us that, in an earlier study, he showed that the generative organs of the least constantly or inconstantly hermaphrodite bony fishes are formed on the female type. The male genital duct is not a permanent structure, but disappears towards the end of development without leaving a sign of its presence.

The author concludes with a few notes on the anatomy and development of other systems of organs. The structural relations of the secreting cells of the foot-gland are of interest, as there are in the adult three different forms of cells. The epithelium of the basal portion forms two ciliated ridges, and is sharply marked off from the pavement epithelium of the side walls. At the base of the groove the sensory cells, as Sochaczewer called them, are situated; Dr. Brock demurs, however, to this view of their function, and thinks that they are nothing more than ordinary cells between which the glandular cells open into the efferent duct, and which are specially modified thereto. On the roof the cylindrical cells are low and devoid of cilia; they are specially remarkable for the longitudinal striation of their protoplasm. The glandular cells are generally arranged in two chief masses on either side of the efferent duct; they are not so arranged as to form compact masses, but only five or six cells form a connected

group; they are open at the base of the ciliated grooves, and a few open in the intercellular spaces of the roof of the duct, or a few unicellular glands in the groove on the lateral margin of the foot.

With regard to the calcareous cells of the liver, Dr. Brock remarks that they were present in the earliest stages of development studied by him; he asserts, as against Leydig, that the foot is continuously ciliated, and he draws attention to the little known fact that the right edge of the margin of the mantle, in the region of the respiratory cleft, is also ciliated.

Nervous System of Ctenobranch Molluscs.*—M. E. L. Bouvier finds that the proboscidial commissure which is found in scutibranch prosobranchiate Gastropods disappears from the ctenobranchiate group; but there is another connective which is very characteristic; it is that which more or less distinctly connects the right commissural ganglion with the subintestinal. This connective results from the anastomosis of the right pallial nerves which issue from the right commissural and from the subintestinal ganglia. The author enumerates various forms in which this arrangement is found. In the Cerithiidæ the conversion of the anastomosis into a connective may be studied step by step. When once formed, it varies very greatly in dimensions.

On the left-hand side the pallial nerve always retains its origin in the commissural ganglion, except in *Ampullaria*, when it is converted into a connective, going from the left commissural to the supra-intestinal ganglion.

Strength of Snails.†—Mr. E. Sandford has found that a snail weighing 1/4 oz. could drag up vertically a load of 2¼ oz. Another snail, 1/3 oz. in weight, could carry horizontally a weight of 17 oz.

Histological Peculiarities of Lamellibranchs.‡—M. L. Roule finds that the blood-channels of Lamellibranchs do not (except in the heart and pericardium) present the histological characters of closed vessels—that is, proper muscular and connective-tissue walls which can be isolated from the surrounding tissues. The canals are simple lacunæ united into a diffused plexus, with the exception of a few which ordinarily communicate between the heart and the organs. These last, which are generally known as arteries, have not really a structure different from that of other lacunæ. Numerous muscular fibres do, indeed, surround their cavities, but they are not proper to them. The connective layer which directly limits the cavity does not differ from that which is situated more deeply, and does not form a special membrane. Just like that of Tunicates, the whole circulatory apparatus of Lamellibranchs recalls the lymphatic system of Vertebrates, and the globules completely answer to those of the lymph.

A state of complete extension is habitual for the turgescent organs of individuals placed under normal conditions of environment; and contraction is a temporary stage, followed by a return to the ordinary condition. In all the turgescent organs the muscular bundles are numerous, and are set in the direction of the retraction and extension of the organs. The siphons and the edge of the mantle are not, any more than the foot, provided with pores, which serve as organs of exit for the blood during contraction or for the admission of water during extension. The mass of blood is of itself sufficient to explain all the variations of volume, according as it is transported from one region to another.

* Comptes Rendus, ciii. (1886) pp. 938–9.
† Zoologist, x. (1886) p. 491.
‡ Comptes Rendus, ciii. (1886) pp. 936–8.

Deep-sea Mollusca.*—In his report on the Brachiopoda and Pelecypoda collected in the Gulf of Mexico and in the Caribbean Sea, Mr. W. H. Dall has an interesting introduction on the deep-sea forms. Large shells appear to be rare at great depths, and when found are very fragile; the tissues are loose and gelatinous, owing probably to the necessity of affording that thorough permeation of the tissues which is necessary to equalize pressure. Almost all the shells are extremely thin and light. The colours are faint or delicate, the iridescence often peculiarly brilliant. Many abyssal shells have a delicate and sometimes profuse sculpture.

Mr. Dall points out that the word "deep" has had many significations; the abyssal area is that in which the temperature of the bottom is known to be quite uniformly cold, where the food cannot vary much in quality or quantity, and where the distribution of life is comparatively sparse and uniform; he applies the term of archibenthal area to the continental region of Prof. A. Agassiz; it is that which lies between the littoral and the abyssal. It is in this that the chief treasures of the dredger are to be found; the littoral and archibenthal faunæ are often entirely or almost entirely dissimilar, but in the far north or in the tropics the species may be found in shallow water of the appropriate temperatures.

The bottom of the ocean is generally composed of fine impalpable mud, and there are no stones or rugose inorganic objects for sedentary molluscs to perch on; the tubes of hydroids and annelids or the long spines of sea-urchins may afford the necessary *points d'appui*.

The author urges that naturalists do not seem to have realized that natural selection "may act, in certain cases, as successfully by confining the inflexibility of a particular stock, as it does in others by seizing the favourable variations of the vast majority of living beings, which vary indefinitely in all directions." It is probable that the few molluscs which have been recognized as having a world-wide distribution owe their uniformity to some such cause as this. The abyssal molluscs are nearly all flesh-eaters, and as they get their food from the constant gentle rain of dead or dying animals, they are not compelled to prey much upon one another.

As it seems to be a general law of animal structures that the greater the number of similar parts in any member of an organic individual, or of similar members, the greater the tendency to vary, first in the minor features of these parts as compared with each other, and secondly in the number of similar parts in any individual as compared with the average number characteristic of the species; and as in the deep sea the factors which affect the tendencies to vary—absence of light, of enemies that can see, of violent motion—are almost eliminated, "the logical result is that we may expect in the deep sea a very wide range of variation in form and sculpture within the specific limits of the 'flexible' species, and an almost complete uniformity over very wide areas of the forms which we may consider as inflexible species." And this, in Mr. Dall's judgment, is what is actually found.

Of the groups of Mollusca described in this report there are 227 species or varieties, 81 of which are new; there are 12 new subgenera or sections.

* Bull. Mus. Comp. Zool. Cambridge, xii. (1886) pp. 171–318 (9 pls.).

Molluscoida.

a. Tunicata.

Morphology of Tunicata.*—MM. E. van Beneden and C. Julin have continued their researches on the morphology of Tunicates. After an historical review of the state of opinion in regard to some of the main morphological problems, the authors proceed to give a detailed account of the embryonic development of *Clavellina Rissoana*.

I. The chief conclusions of the first chapter are as follows:—(1) The first segmentation plane corresponds to the median plane of the gastrula. The entire right half of the body arises from the right blastomere. The median organs, such as medullary tube and notochord, arise from a double rudiment, forming two identical portions, separated by the median plane. In the earliest stages no cells are exactly median. Afterwards, however, this is not so, and some cells may pass from one side to the other. (2) The second plane is transversal, dividing each blastomere into anterior and posterior portions; the third is horizontal. (3) The formation of the ectoderm results from successive protrusions from mixed or undifferentiated elements. After 32 are thus formed the process stops, the endoderm is formed, and the invagination begins. (4) The last ectoderm cells formed as above are always disposed at the periphery of the anterior ectodermic plate, and since the margin of this plate forms the rudiment of the nervous system, it may be affirmed that the cells forming the epidermis are formed before those which give rise to the nervous system. (5) At the 8 stage the tubular and vertical segmentation cavity opens to the exterior at each end; at the 16 stage it is closed, and with the formation of 32 cells it disappears. It has therefore no genetic connection with spaces subsequently occupied by the mesenchyme. (6) When gastrulation begins, the medullary cells which form the outline of the nervous system, are readily distinguishable. They form a ring immediately surrounding the blastopore, and markedly larger in front, than on the side of, or behind, the latter. (7) At the same stage the common outline of notochord and mesoderm is seen to be separated from the rest of the endoderm which forms the gut. The former also appears as a ring round the blastopore. (8) An important portion of the medullary plate lies behind the blastopore, forming part of its posterior lip and contributing to form the arch of the medullary tube. Kowalewsky's results are here confirmed. The process of closure is throughout essentially the same. (9) At no position or stage of development is the medullary plate separated from the epidermis to form the floor of a canal, of which the roof is formed from the epidermis. (10) The nervous system primitively consists of two exactly similar portions, but these come to be intimately connected, and to take up in part a median position. (11) The notochord developes at the expense of the primitive endoderm below the median and problastoporic portion of the medullary plate. It arises in front of the blastopore at the expense of a portion of the rudiment which also forms the mesoderm. It arises as a furrow and forms a cord by the progressive approximation of the margins. It only becomes secondarily median. (12) The mesoderm developes at the expense of the endoderm, in the form of two lateral portions separated dorsally by the notochord, and ventrally by the gut-forming endoderm. An anterior portion is resolved into mesenchyme, the posterior region forms the caudal muscles. The first portion arises in enterocœlous fashion in the form of lateral diverticula from the archenteron. The second portion arises similarly, but this pos-

* Arch. de Biol., vi. (1885) pp. 237–476 (9 pls.).

terior portion is directly transformed into muscular cells. Though the segmentation of the tail is not apparent, it is none the less real. (13) The alimentary canal of the larva is straight and median. It is continued by a neurenteric canal into the medullary tube; but both this and the caudal portion of the intestine disappear. The remainder includes three distinct portions: (*a*) the precordal dilatation, (*b*) a shrunk region, of gutter-like form, open above, and roofed by the notochordal plate, (*c*) a long rudimentary portion, without cavity, lying beneath the notochord as a double row of endodermic cells.

II. *The heart, the pericardium, and the epicardiac tube.*—The open tubular heart has a delicate muscular wall, connected along one line, by a suture or raphe, with the pericardiac epithelium round about. The cardiac cavity arises as an invagination of a portion of the pericardiac wall. They thus really form one sac. The heart is but the visceral layer of the pericardium. If it were not for the absence of a vascular endothelium the ascidian heart would be directly comparable to that of a vertebrate embryo. The epicardium associated with the heart forms a blind tube, forked in front, and opening by two distinct orifices, right and left, into the branchial cavity between the entrance to the œsophagus and the posterior extremity of the hypobranchial groove. The cavities are lined by an epithelium continuous with that of the branchial sac, at the level of the orifices. The whole arrangement is intimately described. The epicardium separates the two principal currents of blood—the postero-anterior, ventral, hypobranchial, or sub-epicardial, from the antero-posterior, aortic, or supra-epicardiac current. The epicardium and pericardium, which are thus physiologically and anatomically associated, arise genetically from the same embryonic formation—the procardium. From the development of this procardium, which is discussed in detail, it is evident that heart, pericardium, and epicardium all develope at the expense of the branchial endoderm. It is further noteworthy that the procardium arises from a double rudiment, and that the right portion is smaller than the left.

In the bud the internal vesicle results from the separation of the two cellular layers adjacent to the stolon partition. The elongated vesicle is divided transversely into terminal and basilar portions, of which the former gives rise to branchial sac and epicardial tube, and to secondary diverticula, the peribranchial cavities and digestive tube. The basilar portion forms the pericardial sac, of which the invaginated roof becomes the wall of the heart. The subsequent changes are described at length, and the authors show that the mode of development, and anatomical relations of the cardiac organs, are different in the forms arising from a urodelous larva, from what they are in those arising from buds. The heart of the adult is then described.

III. The third chapter contains an account of the development of the alimentary tract. The three regions of the larval tract have been noted above. That of the adult arises wholly from the two first portions of the larval mesenteron. The authors' observations show that the branchial sac, the œsophagus, and the stomach are differentiated portions of the one primitive larval rudiment. These three portions have remained median and symmetrical. The stomach ending in a cul-de-sac is prolonged backwards in a short stout cellular cord, the remnant of the caudal portion of the primitive mesenteron. The intestine arises in the form of a secondary diverticulum from the floor of the stomach. It is a new and superadded structure. Its mode of development recalls that of glands. The intestinal cæcum arises to the right at the level of the anterior extremity of the notochord. It originates rather from the precordal, than from the subcordal

portion of the primitive mesenteron. It is certain that the anus does not represent the posterior extremity of the second portion of the mesenteron. It is necessary to distinguish clearly between the descending portion of the tract developing out of the primary rudiment, and the ascending portion arising as secondary cæcum from the floor of the stomach. In every way the adult *Clavellina* is seen to be absolutely like the visceral portion of the larval trunk, extended lengthwise after the atrophy of the tail.

IV. *The reproductive system.*—In this chapter the development of the reproductive organs is described in *Perophora*, *Clavellina*, and *Phallusia*. The genital rudiment is of mesodermic origin, and appears in the concavity of the intestinal curve. The same rudiment forms testis, ovary, and ducts. There is no distinct ovarian rudiment, nor are there two cellular cords, but always only one. The female organ of a *Perophora* or *Clavellina* is simply an embryonic vesicle considerably elongated, in which the epithelial wall forms in certain regions ovarian follicles. A secondary diverticulum arising from the floor of the primitive vesicle is the first rudiment of a testis. The various stages are described in detail.

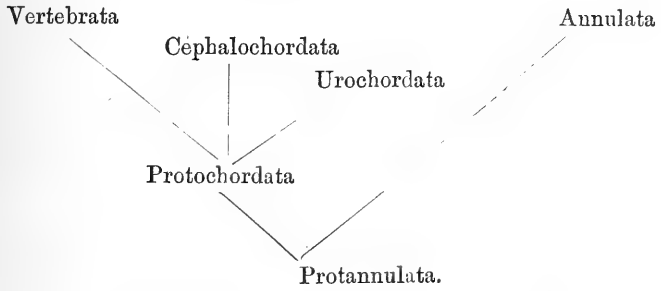
As to *oogenesis*, Kowalevsky's early conclusions are confirmed. The egg-envelope appears after the follicular cells have disposed themselves in two layers. It is therefore of epithelial origin and separates the primitive epithelium into two portions,—the test-layer, and the secondary follicular epithelium. A subsequent subdivision of this external layer, about the time of egg-laying, results in the formation of two layers—one adjacent to the egg-membrane and homologous to the papillary or spumose layer of other Ascidians, the other opposed to the "anhyste" membrane described by Fol in *Ciona* as the membranous follicular layer. The primitive follicular epithelium formed by a simple layer of flat cells is derived from follicular cells interposed between the primordial ovules in the germinal epithelium. This epithelium gives rise to two "membranes anhystes," and to three cellular layers, viz. from the outside inwards—(1) the membrane anhyste of the follicle, (2) the membranous follicular layer, (3) the papillary or spumose layer, not so in *Clavellina*, (4) the "membrane anhyste" of the egg-envelope (Fol's chorion), (5) the testa layer. Of these 1 and 2 remain till the egg is laid; 3, 4, and 5 are expelled along with the egg. The latter is naked and gives rise to no membrane. The envelopes which surround it after, as before laying, are of follicular origin.

V. The fifth chapter discusses the *longitudinal muscles*. In their structure they rather resemble the primitive bundles of vertebrate muscle than the cellular fibres; there is, however, no cross striping.

The remaining hundred pages are occupied with the discussion of general morphological questions raised by the above investigation. The development of *Clavellina* is very intimately compared with that of *Amphioxus*, the question of the vertebration of the larvæ is fully discussed, the morphology of the heart, branchial slits, and various cavities is critically resumed, and the interpretation of Tunicata as degenerate fish is unfavourably criticized.

As to the systematic position of Tunicata, the authors conclude their valuable memoir as follows:—(1) The Tunicata, Cephalochordata, and Vertebrata form a single group—Chordata. (2) The Tunicata have, like the other two divisions, arisen from segmented enterocœlous organisms, like the Archiannelid worms. Animals like Protodrili, but with dorsal chord and anterior respiratory diverticula from the gut, formed the common starting-point for the Chordata. In these Protochordata the posterior portion of the trunk is adapted more especially for locomotion, while the

caudal region of the ancestral digestive tube has undergone progressive atrophy, and the vegetative functions have become more localized in the anterior part of the trunk. This transformation of one part of the segmented body of the vermiform ancestors has affected all the trunk, except the cephalic extremity and first segment of the body, in those forms whence the Urochordata have arisen. (3) The affinities between Uro- and Cephalochordata are much closer than between either and the Vertebrata. This graphic representation is suggested—



Anatomy of Amarœcium torquatum.*—M. C. Maurice gives an account of the heart, alimentary canal, and reproductive organs of the compound Ascidian *Amarœcium torquatum*. A cross section through the middle of the post-abdominal region reveals three cavities, of which the median is shown to consist of an organ (epicardium) depending from the branchial cavity, while the two others are prolongations of the pericardium. The cardiac cavity is open, not only at both ends, but all along. The cleft is situated on the convex face of the crescent formed by the heart, turned from the epicardial sac, which cannot therefore close it. The cells of the cardiac epithelium exhibit on the side of the heart-cavity a layer of muscle-fibrils; the nuclei on the other hand are situated towards the pericardial cavity. Neither heart nor vessels exhibit endothelium.

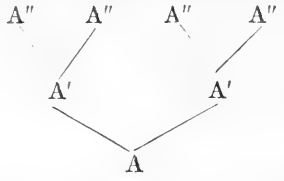
The tubular gland along the intestine is well marked. It consists of many small tubes ending in culs-de-sac, and with a common canal conducting the secretion into the stomach. The anus has a large mouth and several sphincter muscles. The cloacal cavity forms in the reproductive period an incubatory chamber. In this the oviduct also shares. The cloacal orifice bears a series of epithelial languettes.

The reproductive organs are in the post-abdomen on the dorsal side. The ovary is in front of the testis. The oviduct is well defined, attached to the outer surface of the vas deferens. It is flattened, and lined by non-ciliated epithelium, while the vas deferens is round and ciliated. The ovarian cavity is continuous with the oviducal. The flat epithelium becomes at certain points germinal, forming the follicles, from which the mature ova drop off into the cavity. The ovary and testes are never functional at the same time.

Blastogenesis of Botrylloides rubrum.†—M. S. Jourdain disputes the accuracy of some of M. Giard's results with regard to the blastogenesis of this Ascidian, and contends that blastogenesis, with the substitution of bud for parent, is not confined to the postlarval life; it is continuous, that is to say, it happens during the whole life of the stock, and is only accelerated

* Comptes Rendus, ciii. (1886) pp. 504–6. See also this Journal, 1886, p. 955.
† Comptes Rendus, ciii. (1886) pp. 1086–8.

in the postlarval period. Moreover, this blastogenesis is centripetal, the new individuals appearing outside the cycle already in activity. An arrangement which frequently obtains may be indicated by the following diagram:—



It is interesting to note that the buds, to whatever stage they belong, are at first hermaphrodite; in the cold season both glands atrophy as the bud grows; later on, the male gonad alone persists; in warm weather both kinds of gonads are completely developed.

β. Polyzoa.

Phylogeny and Ontogeny of the Polyzoa.* — Herr K. Kräpelin communicates some of the results of a prolonged study of the fresh-water Polyzoa of Germany.

I. *Phylogeny.*—The Phylactolæmata are derived from the Ctenostomata, and especially from forms like *Arachnidium* and *Victorella*, which possess creeping processes with knotted swellings. From these the Paludicellæ first develope with hibernacula or winter buds, comparable to the tuberculate swellings of the former. The hibernacula are true buds, with embryos containing ecto- and endoderm, and represent the statoblasts of the Phylactolæmata and especially those of *Fredericella*, which is not forked like *Paludicella* but bears at the position of the lateral branch an internal statoblast with bivalve shell. The statoblasts of *Fredericella* are borne both on the creeping and on the upright cystids. *Fredericella* is an important transitional form connecting Phylactolæmata and Ctenostomata. Further development occurs along two lines, (*a*) alteration in the consistence of the chitinous ectocyst, and (*b*) multiplication of the number of tentacles. A development of the lophophore, and increased production of statoblasts, are associated with the resulting improvement of nutritive conditions. Statoblasts with and without swimming ring appear together. With increased firmness of ectocyst vertical cystids preponderate as in *Alcyonella*, while the reverse results in hyaline creeping forms. The sessile statoblasts disappear, and spinose anchor-bearing forms with swimming rings replace them.

II. *Ontogeny.*—The *spermatozoa* arise directly from naked "endoderm" spermatides, the head forms the nucleus, and a "residual body" remains. The *ova* also result from "endoderm" cells of the cystid wall, not of the funiculus. They are surrounded by an "endoderm epithelium" and thus form an ovary of the simplest type. They are fertilized in the ovary and do not pass into the body-cavity.

The segmentation results in a mass of uniform cells. These differentiate into two groups of which one forms the embryo, while the other is apposed to the maternal embryonal envelope and degenerates. A blastula with wide central cavity is formed, and some kind of embolic process forms a "gastrula." The gastrula-cavity is the future body-cavity, and its layers

* Biol. Centralbl., vi. (1886) pp. 599-602 (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886).

are the "ectoderm" and "endoderm" of the cystid. An invagination at the anterior pole forms the polypide. The "ectoderm" forms the intestinal epithelium, and from it the ganglion is separated off. The alimentary canal is a simple invagination of the cystid wall. An upward curvature precedes the rupture into the tentacle disc, and with this is associated the formation of three dorsal invaginations, into the cavity of the two-layered polypide-bud. Of these the two lateral form the lophophore, while a median represents the sharp twist of the hind-gut towards the œsophagus.

Herr Kräpelin would regard the hypoblast of the gastrula as mesoderm. The archenteron is thus an enterocœl, and the intestinal epithelium of the polypide-bud is the true endoderm arisen by gastrulation. The theory of the double character of the Polyzoon (cystid and polypide) is thus gratuitous, and the Polyzoa form a welcome connecting link between Cœlenterata and Enterocœlia.

The ciliated embryo leaves the maternal body-cavity through a "prolapsus uteri" in the dead polypide. He confirms Nitsche's account of the development of statoblasts. They too arise from *both* layers of the funiculus. One portion of the "ectoderm" forms the chitinous shell, while the other developes directly into the outer layer of the body-wall of the statoblast embryo. The development of the sessile statoblasts is essentially similar to that of the free forms with the ring of air-cells.

Blastogenesis in the Bryozoa.*—M. A. A. Ostroumoff has some remarks on M. L. Joliet's recent paper on blastogenesis in the Bryozoa; the "rudiment of the digestive canal" is, M. Ostroumoff thinks, nothing more than a mass of lymphatic cells; on this subject reference is made to Kükenthal's observations on the lymphoid cells of Annelids. The figures of Nitsche are defended against Joliet's criticisms.

Life-history of Pedicellina.†—Mr. S. F. Harmer, from a personal study of the metamorphosis of *Pedicellina*, has been led to confirm Barrois' account, and to withdraw his previous opinion; he now concludes that the postlarval changes consist in a remarkable metamorphosis, and that the first bud is formed after the primary individual has acquired its adult characters. The author thinks that the metamorphosis of *Pedicellina* is a simple modification of a more archaic process, due to abbreviation of development, that the oral groove persists partly as the adult lophophore, and that the vestibule closes at fixation and undergoes the whole of its alterations in the interior of the larva; a secondary opening is effected when the adult condition is practically attained.

It is probable that the growing point of a stolon of *Pedicellina* consists solely of an ectodermic layer secreting a cuticle, and a mass of indifferent connective-tissue cells, imbedded in a structureless jelly. With regard to the so-called brown bodies of the Ectoprocta, Mr. Harmer cannot doubt but that they are degenerated polypides; in *Pedicellina* degeneration is too slight to give rise to a characteristic brown body.

Recent Marine Polyzoa.‡—Mr. G. R. Vine has drawn up for the British Association a report on recent Cheilostomatous and Cyclostomatous Polyzoa, in continuation of his reports on the fossil forms; especial attention is given to the recent works of Mr. Busk and the Rev. T. Hincks, and their terminology is explained. The present notice deals more with the home of than with the animal itself; for the study of the latter the author

* Zool. Anzeig., ix. (1886) pp. 618–9.
† Quart. Journ. Micr. Sci., xxvii. (1886) pp. 239–63 (2 pls.).
‡ Report. Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 481–680.

recommends the mastery of the details furnished by Barrois on their development, and a study of mounted or living specimens of *Carbasea* for the Cheilostomata, of *Zoobotryon pellucidus* for the Ctenostomata, and *Crisia foliacea* for the Cyclostomata. After a tabular list of families and an index of names, the author enters on the systematic arrangement of the genera and species; the synonymy is here given, and there is an elaborate list of synonyms given in index form. These are followed by tables of geographical and bathymetrical distribution arranged by authors—a not very convenient arrangement. The whole concludes with a bibliography.

Polyzoa of the Black Sea.*—M. A. A. Ostroumoff communicates a lengthy memoir on the Polyzoa of the Gulf of Sebastopol. He distinguishes 11 species, 6 in the zone of the Ulvas and Zosteras, 5 in the zone of Phyllophoreæ.

I. In his general introduction the nomenclature and general features are discussed; he distinguishes the calcareous *Cheilostomata* from the chitinous *Ctenostomata*. In the former the typical zoœcium is a tetragonal box. Of the two transverse faces, that with the orifice is termed "opercular" or "pallial," and that by means of which the colony is fixed—"basal." The orifice does not always open in the centre of the opercular face, but near one of the sides, which he terms "distal" or superior, while the opposite one is termed "proximal" or inferior. The *Cheilostomata* have a semicircular operculum; the *Ctenostomata* have none. The modifications in various subdivisions are briefly noted. Among ovicells the author distinguishes (1) those forming an integral part of the colony, with the whole zoœcium (except the digestive tube) subordinated to containing the ova formed at the expense of the nearest complete zoœcia; and (2) those acting rather as organs, and occurring on certain zoœcia only during sexual maturity. The *Cheilostomata* are covered with spicules, which probably increase the respiratory surface. The skeleton of the zoœcium exhibits pores on the basilar surface, opening communication between mother and daughter zoœcium, or on the lateral surface connecting adjacent zoœcia, or thirdly, on the opercular face communicating directly with the exterior. Nine species are then diagnosed at some length.

II. *Anatomical results.* (*a*) *Derivatives of the ectoderm.*—On the polyzoon larva or young bud a delicate ectoderm is readily detected below the cuticle. This soon exhibits a sort of cellular separation; the nuclei go apart; the protoplasm gathers round them and forms irregular prolongations, and a reticulated appearance results. The great difficulty of perfect fixing has led to varied descriptions by different observers. The skeletal development is then described, and the means taken to secure efficient respiration are noted. Internally the ectoderm gives origin to the epithelial membrane of the tentacular sheath, to the stomodæum, proctodæum, superior cells of the tentacles, and nervous ganglion. These are then discussed in order.

(*b*) *Derivatives of the endoderm.*—The median portion of the alimentary canal, viz. the stomach, with its ciliated pyloric portion and cæcal appendage, are of endodermic origin. The stomach proper lies between the cardiac thickening and the pyloric chamber. With the endoderm there is further associated the "brown mass," which has been so variously interpreted as ovary, embryonal capsule, &c. It is doubtless a stomachic cæcum in which the ordinary secreting function of the cells has been replaced by that of assimilating the products of cellular degeneration. The brown mass includes not only the cæcum and detritus, but a button-like mass of

* Arch. Slav. de Biol., i. (1886) pp. 557-69 (5 pls.); ii. (1886) pp. 8-25, 184-90.

cells, which become attached to the ectodermic portion of the alimentary canal to form the median or endodermic region.

(*c*) *Derivatives of the mesoderm.*—In the marine Polyzoa the general cavity is not lined by a mesodermic epithelium. The walls of the zoœcium only exhibit a single sub-skeletal layer of ectodermic cells. Scattered mesoderm cells occur near the wall, attached on the one hand to the ectoderm, and internally to other cells forming a funiculus. These mesoderm cells are better described as funicular than as parenchymal tissue. The muscular system is described in detail. Those of the digestive tube or polypide are to be distinguished from the parietal and opercular muscles of the zoœcium. Histologically there are three groups: (*a*) muscles composed of isolated filiform fibres, with undifferentiated contractile substance, covered by a delicate sarcolemma, best seen near the spherical nucleus, which lies near the middle of the fibre; (*b*) muscles in which the extremities enlarge at the punctum fixum into a long triangular band; (*c*) muscles of the principal retractor, transversely striated, but only peripherally, so that the central substance remains undifferentiated. The reproductive organs are also mesodermic. The products fall into the cavity of the zoœcium, and thence into the tentacular sheath, which ruptures in admitting them.

(*d*) *Development.*—Herr Ostroumoff finally distinguishes and describes three types of larvæ:—(*a*) the ordinary type of Chilostomata, (*b*) the Cyphonaut type, (*c*) the vesicularid larva or Ctenostoma type. A brief notice of the metamorphosis (generally corroboratory of Barrois) concludes all that has yet been published of this memoir.

Arthropoda.

Spermatogenesis of Arthropods.*—Herr H. de Wielowieyski reports some of the results of his researches on Arthropod spermatogenesis, which were independent of the investigations of Prof. Gilson, though mainly corroborating his conclusions.

1. Contrary to the opinion of several observers of vertebrate spermatogenesis, Wielowieyski maintains that the chromatic nuclear filament of the spermatocyte is not directly formed into the head of the spermatozoon, but breaks up, becoming thoroughly distributed among the achromatic plasma.

2. While Gilson explains the multinuclear spermatogonia as the result of endogenous division, Wielowieyski maintains that they arise by the very complete fusion of individual cells.

3. In *Asellus aquaticus* Gilson notes how the mother sperm-cell divides into two, of which the one portion continues to divide into spermatocyte nuclei embedded in the common protoplasm, while the outer half (which he calls female) remains passive and undivided, finally, however, disintegrating. This suggestive history is denied in toto by Wielowieyski, who maintains that here also the mother sperm-cell divides into separate spermatocytes. The appearance Gilson described, he regards as due to artificial confluence.

4. In insects, Gilson described the developing spermatozoa plunged in the remnant of the protoplasm of the spermatogonium, with one or more (female) nuclei in the wall. The envelope round such a bundle appeared to Wielowieyski, on the other hand, distinctly cellular, in fact an epithelium.

5. In conclusion he notes the presence of accessory cells occurring

* Arch. Slav. de Biol., ii. (1886) pp. 28–36.

among the sperms in the ejaculatory tubes of *Melolontha vulgaris*, and apparently also the direct results of spermatogenesis.

Bacteriological Studies in Arthropods.*—M. E. G. Balbiani finds that saprophytic bacilli, when inoculated into the blood, are pathogenic for a large number of Arthropods. Death follows in from twelve to forty-eight hours, according to external temperature, number and origin of spores, size, age, and susceptibility of the subject. They die with all the symptoms which characterize the disease known as "flacherie" in silk-worms, a malady determined by the development of various species of bacteria in the organism. Insects of different orders are not equally susceptible; those which contain a small quantity of blood in proportion to the mass of the body (Lepidoptera, Diptera, Hymenoptera) are killed more rapidly and surely than those in which the relative proportion of blood is greater, and (above all), in which the blood is richer in corpuscles; this is specially the case with the Gryllidæ.

The resistance is due to the corpuscles seizing by their pseudopodia on the bacilli, and to the elements of the pericardial tissue, which seize on and destroy the poisonous organisms. This identity in mode of action is ascribed to the genetic relation which exists between the two kinds of cells. Death is delayed if the spores are kept for more than six years in a state of desiccation.

a. Insecta.

Spermatogenesis of Beetles.†—Prof. v. La Valette St. George adds a fourth communication to his recent studies on spermatogenesis. He now discusses that of beetles as illustrated by *Phratora vitellinæ* and a few other forms.

The general facts remain the same, the details alone vary. Primitive sperm-cells, spermatogonia, spermatocysts of spermatocytes, spermatides and spermatozoa follow one another as usual. Recent researches by Gilson and Spichardt are critically referred to. The cellular cyst-skin ("Cystenhaut") round the spermatocysts was well seen; it usually contained two nuclei. As usual, the nuclei of the spermatocytes are often divided without the protoplasm being divided and rounded off about them.

In the spermatocyte the neighbour nucleus (accessory nuclear body —"Nebenkern") appears as a simple thickening of the cytoplasm near the nucleus. It becomes associated with the nuclear contour like the stamp on a signet ring. It exhibits a threadwork structure, as is intelligible from its association with mitosis, sharing in the formation of the spindle-fibres, and representing the residue of nuclear threads after the formation of daughter nuclei. In the spermatide the neighbour nucleus retains for a while its threadwork, but sends out a fine process, the first hint of the sperm. Together with the nucleus it forms the head of the latter. Two threads in the tail were detected. It appears as if both tail and head were ensheathed in a special layer of cytoplasm, while its variable contractility presents the different appearances often described.

Oogenesis of Insects.‡—Herr F. Blochmann reports the results of his investigation of the much-discussed oogenesis of insects. His conclusions are not corroboratory of Will's statements. The young ovum has a large, but not very richly chromatic nucleus. As the ovum enlarges, vacuoles

* Comptes Rendus, ciii. (1886) pp. 952–4.

† Arch. f. Mikr. Anat., xxviii. (1886) pp. 1–13 (4 pls.).

‡ Festschrift d. Naturh.-Med. Vereins Heidelberg, 1886. Cf. Biol. Centralbl., vi. (1886) pp. 554–9.

appear close round the surface of the nucleus, and in these a small granule appears. They look like nuclei, in fact, and are termed by Blochmann "neighbour-nuclei" ("Nebenkerne"). They increase in number and the principal nucleus becomes smaller.

In the hitherto granular protoplasm a peculiar structure appears like a much-coiled bundle of threads. They consist of regular rows of rod-like bodies 10–12 μ in length, like bacteria, and multiplying by division. At an earlier stage similar bodies are seen in the epithelial cells. They are dissolved in 5 per cent. soda solution, cannot be cultivated, and are not bacteria. At the beginning of yolk-formation they retire to the posterior pole and spread out under the blastoderm. After a while they pass into cells of the embryo. They are not unlike the bacteroids developed in the tubercles on leguminose roots and known to be albuminoid bodies.

As the yolk appears the neighbour-nuclei are scattered over the surface of the ovum, where they are for long visible among the yolk spheres, eventually, however, disappearing. They have no connection with follicle-formation.

The yolk-formation occurs first in the portions next the follicular epithelium. Vesicles appear, first with granules and then with a firm network. These pass inwards, and the peripheral ovum protoplasm forms more. The so-called nutritive cells must aid in equipping the egg, but there is certainly no reception of formed yolk-particles by the egg from outside. A distinct yolk-nucleus was observed.

The germinal vesicle retains its position at the anterior end of the ovum and forms a nuclear spindle. Hints of a polar cell were detected. In three different orders of insects Blochmann demonstrated the presence of germinal vesicles, which does not agree with Stuhlmann's recent observations. In *Musca vomitoria* a polar cell was distinctly observed, and its mode of formation was normal.

In reference to the difficult problem of the relations of yolk, epithelial cells and ova in insect oogenesis, Dr. J. H. List * communicates the result of some observations on *Orthezia cataphracta*.

1. Each tubule exhibits a superior terminal yolk-chamber, and an inferior egg-chamber. The latter is lined by high cylinder epithelium, lower in the terminal chamber.

The terminal chamber exhibits at an early stage, yolk flakes formed from modified epithelial cells. Traces of the component cells are for a while visible in the form of nuclei and cell-boundaries. The nuclei degenerate, however, and are replaced by a new large nucleus. These yolk-cells break down into yolk granules and form the yolk of the ovum.

2. The ova arise from the epithelium of the egg-chamber, by a modification, perhaps budding of one, or rarely more of the lining cells. The appearance at different stages is briefly noted.

Origin and Significance of Cellular Elements of Ovary of Insects.†—Dr. E. Korschelt concludes that the various cellular elements of the ovarian tubes of insects—ova, nutrient cells, and epithelium—all arise from similar indifferent elements, which are found in the contents of the first rudiment of the tubes; the first formation of the cells and the connected differentiation of the several segments of the tube commence in the embryonic period; that is, during larval life. The indifferent elements correspond to the embryonic condition, and they in post-embryonic and even during imaginal life, continue to give rise to fresh supplies of the various kinds of cells. Different

* Biol. Centralbl., vi. (1886) pp. 485–8.
† Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 537–720 (5 pls.).

insects differ greatly in the way in which the various kinds of cells are formed from the indifferent elements. It is clear from their histological peculiarities, and from the mode of origin of their elements, that the ovarian tubes which are of complex structure and are provided with nutrient chambers, must have been derived phylogenetically from tubes without nutrient chambers. In some cases the nutrient cells are formed at the same time and in the same way as the germinal cells, and they are then to be regarded as germinal cells which have gradually lost the function of forming ova and have taken on that of producing nutrient substance.

In the ovarian tubes which have several nutrient chambers the nutrient cells may be formed at the same point as the egg-cells, and even later they may be found mixed up with them at the commencement of the tube. The tubes with a terminal nutrient chamber appear to have been formed owing to the capacity for forming ova having been handed over from the primitive germinal cells at the tip of the chamber to those which lie at its base. The nutrient cells of other forms arose independently of the germinal cells, and must not therefore be referred to them. In all forms the epithelium is developed in much the same way, and always has a great resemblance to the indifferent elements of the terminal chamber from which it directly arises; the author was never able to convince himself of the formation of epithelium from germinal vesicles, from the nuclei of nutrient cells, or from the so-called ooblasts. Neither the ova of Hemiptera or any other insect are formed of ooblasts, but arise, like the epithelial and nutrient cells, by the gradual differentiation of the indifferent elements of the ovarian tubes. All the various elements of the tube are morphologically of the value of cells.

Chemical Composition of Ova.*—Herr A. Tichomiroff has analysed the ova of *Bombyx mori*, and compared the composition before, and at the close of incubation. The shell contains a substance which he terms chorionine, containing less sulphur than keratine. The proportions of albumen and insoluble salts, of aqueous extract and glycogen, of ethereal extract, fat, lecithin, and cholesterine, of chorionine and chitin, of nitrogenous bases, are noted. Before incubation the ova contain 100 parts of liquid material and 35·5 of solid substances, while at the close of incubation the respective figures are 88·8 and 30·2. In developing, the ova therefore lose 7 per cent. of water and 3 per cent. of solid material. The loss is principally in glycogen and fat.

Law of Orientation of the Embryo in Insects.†—M. P. Hallez has continued his observations on the relations which exist between the principal axis of the mother and the organic axis of the egg, and between the organic axis of the egg and the principal axis of the embryo. The insects best adapted for such investigations are those which deposit their ova in cocoons, those which have an oviscapt, or such as have certain peculiarities, such as micropylar appendages

The first form described is *Locusta viridissima*, where it was found that the head of the embryos is always formed at the superior part of the egg, and that the convex line of the ovum corresponds to the dorsal surface of the embryo.

In *Hydrophilus piceus* the head, contrary to what obtains in most cases, looks downwards; the principal axis of the embryo has the same orienta-

* Zeitsch. f. Physiol. Chimie, ix. (1885) pp. 518-32. Cf. Arch. Slav. de Biol., ii. (1886) pp. 133-4.

† Comptes Rendus, ciii. (1886) pp. 606-8.

tion as the same axis of the mother. The author concludes with the generalization that, in insects, the egg-cell has the same orientation as the mother, has a cephalic and a caudal pole, a right and left side, and a dorsal and a ventral surface, and that these correspond to those of the embryo.

Artificial Parthenogenesis.*—Herr A. Tichomiroff has investigated the parthenogenesis of the ova of *Bombyx mori*. The really parthenogenetic reproduction is confirmed, and it is also shown that ova which would not of themselves develop parthenogenetically might be induced to do so by certain stimuli. These stimuli consisted in rubbing the unfertilized ova with a brush, or in dipping them for two minutes in concentrated sulphuric acid, and then washing them. In both cases a percentage of the stimulated ova developed, but in the unstimulated parthenogenetic lot none seemed able to do so.

Thoracic Salivary Glands homologous with Nephridia.† — As the result of some studies on the structure of lower insects (*Campodea*, *Lepisma*, *Mactilis*, &c.), Herr N. Nassonow has been led to the conclusion that a portion of the efferent ducts of the male genital organs develope from the mesoderm, and that the thoracic salivary glands of insects are homologous with the segmental organs of worms. It is further probable that the oviducts also, several accessory glands in association with the reproductive organs, and likewise the abdominal tubules of *Campodea* and *Mactilis* are remains of segmental organs.

Leydig's Cord.‡—In studying the eggs of *Blatta germanica* and some embryos of *Melloe proscarabeus*, Herr J. Nussbaum noted the presence of an organ which he regards as homologous with the notocord of vertebrates. It is, however, of mesodermic origin. The cord found by Leydig in 1862 is regarded as homologous to the external neurilemma of the nervous system plus the cellular-connective tissue of the abdominal diaphragm.

Ants and Ultra-Violet Rays.§—Whilst Sir J. Lubbock considers that ants perceive the ultra-violet rays by means of their eyes, Graber finds, by removing these organs from tritons, &c., that it is by the skin that these rays are perceived. Prof. A. Forel has made experiments in order to answer the question whether ants perceive these rays by means of their eyes, or by the skin; and he finds that it is mainly by the former organs, but admits that "photodermatic" perception may accompany the optic sense. *Camponotus ligniperdus* and *Formica fusca* served for his experiments, and a "solution d'esculine" was used for absorbing the ultra-violet rays.

Insect-skin.‖—Prof. C. S. Minot distinguishes on the cuticle of insect larvæ a very thin lamella, often markedly pigmented. The surface is usually divided into areas, each of which corresponds to a subjacent epidermal cell. The middle of each area usually projects, and the lamella covers the elevations with its pigmented sheath. The form and pigmentation of these areas vary greatly, and may be utilized for diagnostic purposes. In primitive forms like *Peripatus* and in some Orthoptera, the elevation of the thick cuticle over each cell bears a number of small points. The boundaries of the areas may disappear, and the points remain or be reduced in number. Or the elevations may remain and the points fuse together.

* Arch. f. Anat. u. Physiol. (Physiol. Abtheil.) 1886, Supplement, pp. 35–6.
† Biol. Centralbl., vi. (1886) pp. 458–62.
‡ Kosmos (Polish) 1886. Cf. Arch. Slav. de Biol., ii. (1886) p. 291.
§ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 346–50.
‖ Arch. f. Mikr. Anat., xxviii. (1886) pp. 37–48 (1 pl.).

By a further change the whole elevation is covered by an uninterrupted pigmented lamella, as in many butterflies. These pigmented elevations may be thick or sparse, hair-like or simply pointed, and so on. Some reference is made in this connection to fossil caterpillars.

Morphology of Insects' Wings.*—Herr N. Cholodkovsky commences by stating that, notwithstanding all the text-book statements to the contrary, the first ring of the thorax of Lepidoptera is in no way connected with the second. At the boundary between its notum and pleuron there is, on either side, a hollow evagination of the chitinized skin, which is, in an uninjured specimen, closely covered by hairs and scales. In position and form this outpushing is exactly like the rudiment of a wing, and it would hardly be wrong to call it the rudimentary prothoracic wing. Not only has the author observed these rudiments in various Lepidoptera of all the most important families, but Fritz Müller has seen them in some Termite-larvæ; Woodward has described a fossil (*Lithomantis carbonaria*) with two wing-like appendages to its prothorax, and Graber has discussed the matter.

The physiological significance of these appendages is very difficult to understand, but it is important to observe that there are no indications of them in the larva (of *Vanessa urticæ*, at any rate). The wings were probably preceded by appendages on all segments of the body, and these probably had a respiratory function in those terrestrial insects from which probably all forms, whether now aquatic or terrestrial, have been derived.

With regard to this communication, it is pointed out by Dr. E. Haase† that the structures now discovered were seen in 1822 by Chabrier in *Macroglossa stellatarum*, that Kirby and Spence distinguished them as the prothoracic "tippets" (patagia), from the mesothoracic wing-covers (tegulæ); Burmeister and Westwood have also mentioned them. In 1870 Speyer gave a detailed account of them, and pointed out that though they were found only among the Lepidoptera, they could not be regarded as characteristic inasmuch as they varied so much in different members of the order. They are not to be regarded as anything more than secondary dermal folds, thickly scaled on their upper surface only. They may have their homologues in the accessory dermal folds of the Diptera, and the patagia-like structures which are found on the prothorax of some Hymenoptera.

Colour of Pupæ.‡—The cause of the relation of pupal colour to that of the surface on which the larval skin is shed, is the subject of experiments by Mr. E. B. Poulton, who confirms Mr. T. Woods' results.

The metallic colour common to the pupæ of the Vanessidæ can be controlled by choosing appropriate surroundings for the larva before pupation; a gilt surface rendering the colour more metallic; a black almost does away with it. The author finds that the colour corresponds with the length of time the larva has been on such a surface before pupation, and that it acts before the moult; the colour affects neither ocelli nor the sensitive spines exclusively. Experiments were made with an apparatus by means of which the larvæ could be suspended partly over a black and partly over a metallic surface, and the author concludes that there is either some terminal organ in the skin, which is affected by the surrounding colour, or that the colour acts directly on some superficial element in the larval tissues without the intermediation of the nervous system.

* Zool. Anzeig., ix. (1886) pp. 615–8.
† Tom. cit., pp. 711–3.
‡ Trans. Entom. Soc. Lond., 1886, pp. xlvi.–xlviii.

Structure and Life-history of the Cockroach.*—Prof. L. C. Miall and Mr. A. Denny have published a work on the structure and life-history of the cockroach (*Periplaneta orientalis*), which they hope, and we expect, will serve as an introduction to the study of insects. They have the aid of Prof. F. Plateau in dealing with the respiratory movements of insects, of Herr J. Nusbaum when treating of the embryonic development, while Mr. S. H. Scudder writes on the cockroach of the past. The work is illustrated by 125 woodcuts, many of which are new, and most of which are good, and references are given to the monographic writers and to those who have specially treated of various organs. In an appendix there is a list of the parasites of the cockroach; the authors do not seem to be aware of a popular article, conceived in a scientific spirit, written several years ago by Prof. Ray Lankester on this subject.

Relationship and Relative Age of Noctuæ and Geometræ.†—Herr L. Knatz has studied *ex ovo* the larvæ of various Noctuæ and Geometræ; as to the former, he finds that the larvæ have not always at first their full number (sixteen) of legs, and that at such stages they exhibit the mode of movement and other characteristic peculiarities of the Geometræ. He concludes that if ontogeny is an epitome of the phylogeny, it is justifiable to suppose that the Noctuæ are of later development than and derived from geometrid forms. Further proofs of this position are to be found in the more complete character of the *Noctua*. The author suggests that the examination of the young stages of insect-larvæ, especially of the Lepidoptera, may clear up some points in the phylogeny of the larger divisions, and aid the work of embryology. It may, however, be pointed out that the author makes no reference to a view widely held, and thus expressed by Balfour:‡—"The characters of the majority of existing larval forms of insects have owed their origin to secondary adaptations."

Forms of Caterpillars.§—In studying the young forms of caterpillars, Herr L. Knatz found that many Noctuæ caterpillars are exactly like Geometræ forms, and that it is only after the second skin-casting that they acquire the originally absent seventh and eighth pairs of legs. Similarly, the subsequently naked Noctuæ forms are more or less hairy in their younger stages. The same is true among Geometræ in *Lophopteryx camelina* and *Saturnia pyri*. The two families are regarded as most closely allied, and the Geometra form of caterpillar ("Spannerraupe") is older than the Noctua type ("Eulenraupe").

Primitive Insects.‖—Prof. B. Grassi, in his studies on the primitive Tracheata, gives a detailed account of *Japyx*. The purely systematic relations, the geographical distribution, and the anatomical facts are discussed in order. Some embryological facts are also noted. The segmentation of the *Japyx* ovum is like that of the typical insects. As in *Hydrophilus*, *Gryllotalpa*, and the Collemboli, there is a dorsal organ, which Grassi is inclined, with Korottneff, to regard as a sort of stopper closing the "umbilical passage." The author also maintains the formation of an amnion.

Japyx and *Campodea* are closely related, and the characters which connect them with Chilopoda on the one hand and Collemboli on the other

* 'The Cockroach. An Introduction to the Study of Insects.' 8vo, London and Leeds, 1886, 224 pp. (125 figs.).

† Zool. Anzeig., ix. (1886) pp. 610–2. ‡ Comp. Embryology, i. p. 352.

§ Festsch. Ver. f. Naturk. Kassel. Cf. Naturforscher, xix. (1886) pp. 408–9.

‖ Atti Accad. Gioenia Sci. Nat. Catania, xix. (1885) 5 pls. Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 40–2.

are emphasized. He weighs the arguments in favour of *Japyx* and *Campodea* being degenerate rather than primitive, but firmly maintains the latter, regarding them as approximately ancestral forms of the winged insects.

Anatomy of Machilis.*—Continuing his researches on primitive insects, Prof. B. Grassi describes in detail the anatomy of two species of *Machilis*, which he compares throughout with *Japyx* and *Campodea*. From the tracheal system especially, he is inclined to regard *Machilis* as the form nearest to the primitive insect type. The structure of the two species is regarded as sufficiently distinct to warrant the erection of a special family, *Machilidæ*. The habit of the Orthoptera begins to be accentuated in *Machilis*, and more so in *Lepisma*. Grassi notes the return to the old system, to which his researches have done much to supply a new morphological basis.

Structure and Metamorphosis of the Aspidiotus of the Rose-laurel.† —The presence of this Coccidian is revealed by numerous whitish spots on the under side of the leaves of the rose-laurel. M. Lemoine finds that the female consists of an oval sac filled with eggs, with neither antennæ, eyes, nor legs. The adult male possesses long antennæ, four large eyes, two wings, balancers, and well-developed legs. The author has studied the whole series of changes passed through by male and female during development. Both sexes are similar up the third age, i. e. after the second ecdysis; the female stops here; but the male goes on through a fourth ecdysis, when it becomes a nymph, and then after a fifth is the perfect insect. The result of these researches does away with the supposed exceptional characters of the development of this insect.

β. Myriopoda.

Light-perception by Myriopods.‡—Fourteen years ago Pouchet showed that muscid larvæ without eyes were still sensitive to light, and Graber has recently in some striking experiments extended the same conclusion. Prof. F. Plateau gives a careful historical survey of what is known in regard to light-sensitiveness among Invertebrates, and reports the result of his own recent researches on blind myriopods.

His method of experiment was manifold. That of Pouchet, that of Graber, and two other modifications were employed in order to determine whether the blind myriopods were able to perceive light, while in another series M. Plateau sought to ascertain the rapidity of perception.

His chief results are summed up as follows:—The blind chilopod myriopods perceive the daylight, and are able to choose between it and darkness; in the chilopod myriopods provided with eyes, and in those without these organs, a considerable time must elapse before the animals perceive that they have passed from relative or complete obscurity to daylight; the length of this latent period is not greater in the blind myriopods than in those with eyes; owing to the general slowness of perception, blind myriopods, although sensible of the light, may cross a dark space of small extent without perceiving it, or being able to find it again when they have left it; the rapid search for a hole in the soil is explicable, not only as a flight from the light, but as an expression of the necessity for a damp environment, with which the greater part of their body may be in direct contact.

* Atti Accad. Gioenia-Sci. Nat. Catania, xix. (1885). Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 92–4.

† Comptes Rendus, ciii. (1886) pp. 1200–3.

‡ Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 431–57.

Morphology of Scolopendrella.*—Prof. B. Grassi gives a detailed account of *Scolopendrella*, in its systematic, geographical, and anatomical relations. The affinities of *Scolopendrella* with *Pauropodi*, with fossil myriopods, with Chilopoda and Diplopoda are discussed. In none of these orders can *Scolopendrella* be incorporated. Without as yet definitely stating the systematic position of *Scolopendrella*, Grassi advances various arguments in favour of relationship with *Machilis*, *Japyx*, *Campodea*, &c.

δ. Arachnida.

Affinities of Arachnida.†—Herr W. Schimkiewitsch discusses the limits and relationships of the Arachnida, with a critical review of the history of opinion and investigation on this subject. (1) Haller's separation of the Acarina he regards as sufficiently answered by Cronenberg. (2) The proboscis of the Pycnogonidæ he compares to the rostrum of spiders; the mandibles are the homologues of the cheliceræ; and the four pair of appendages in the two types also correspond. As to the palps and oviferous

Aberrant Forms.

The number of unjointed appendages and stigmata by which the bundles of tracheæ open, corresponds to that of the segments of the body.

<table>
<tr><td colspan="4">Two anterior pairs of appendages become buccal.</td><td>Peripatus.</td></tr>
<tr><td colspan="4">The appendages become jointed.</td><td>Pauropus.</td></tr>
<tr><td rowspan="2">The head-lobe loses the antennæ, and the posterior segments of the abdomen (post-abdomen) lose their appendages (and their stigmata).
Embryonic state of Arachnida.</td><td rowspan="2">The segments which correspond to the abdomen of the Arachnida each bear a pair of appendages.
Chilognatha.</td><td colspan="2">The third pair of appendages become buccal.</td><td rowspan="2"></td></tr>
<tr><td>Chilopoda.</td><td>Scolopendrella and Collembola (Thysanura).
Insects.</td></tr>
<tr><td>The abdomen only retains one pair of appendages; the tracheæ are replaced by lungs, of which the number is reduced to four pair.
Scorpionidæ.</td><td colspan="3"></td></tr>
</table>

appendages, the former are comparable to the palps of spiders, while the latter perhaps arise from modified development of the maxillary endopodium. The *Pycnogonidæ* are at once primitive and arrested forms. (3) In regard to the Linguatulidæ and Tardigrada, the author does not consider Graff's

* Mem. R. Accad. Sci. Torino, xxxvii., 2 pls. Cf. Rev. Ital. Sci. Nat., ii. (1886) pp. 51–4.

† Arch. Slav. de Biol., i. (1886) pp. 309–19.

proposal to rank them along with Myzostomidæ in the class Stelechopoda is as yet warranted. (4) After balancing the arguments in regard to the wider homologues of the Arachnida, he compares spiders with insects. The insect antennæ have no homologues, but embryonic labra correspond to rostrum, mandibles to cheliceræ, first maxillæ to maxillæ, second maxillæ to first pair of legs, and then three pairs of legs are left to each. (5) So he compares the larva of Chilognatha with that of Acarina; the antennæ of the former are again without counterpart in the latter, but mandibles correspond to cheliceræ, maxillæ to maxillæ, three pairs of legs to the three pairs of thoracic ditto, and lastly, the myriopod segments with two pairs of appendages in the adult, to the abdominal zonites of the latter. (6) Schimkiewitsch maintains the Crustacean character of *Limulus*, and regards the first two appendages of the latter as equivalent to the Arachnid cheliceræ and maxillæ. The abdominal appendages of the *Limuli* are represented by the embryonic abdominal appendages of Arachnids. (7) After noting the ancestral character of *Pauropus*, the author sums up in the tabular survey which appears on the preceding page.

Embryology of the Scorpion.*—Prof. A. Kowalevsky and M. A. Schulgin have investigated the embryology of the scorpion, *Androctonus ornatus*.

1. *The differentiation of the germinal layers.*—Segmentation begins in the uterus; no cells or nuclei occur in the yolk; a single-layered blastoderm is formed at one pole. In the middle of the lower surface of the layer some cells are pressed in to form the beginning of the endoderm. On the surface of the round germinal disc a round groove is formed, uniting the central mass. In this an albuminous fluid gradually accumulates. The margins of the groove grow up, arch over, meet and inclose the germinal disc. Into this duplicature of the upper layer cells from the endoderm penetrate. The inner layer of the embryonic membrane thus formed is continuous with the endoderm and is the amnion proper, the outer layer passes into the ectoderm, and is the serous envelope. Between the two a few mesoderm cells can be detected. The round germinal disc elongates, and one pole (the future post-abdomen) becomes thicker and longer, the other (the future head) remains thin and broad. Meanwhile yolk-cells from the disc wander inwards, become amœboid, and dissolve the yolk mass.

2. *The formation of the alimentary system.*—Ectodermic invaginations form the fore and hind gut. The muscular sheath is formed from the mesoderm. From the lower, properly speaking endomesoderm layer, the true endoderm is separated off as a thick row of cells closely apposed to the yolk, round which the various layers then begin to grow. The endoderm cells become filled with the yolk material, and form a thick inclosing layer. When the yolk is completely surrounded, the post-abdomen developes as an elevation composed of all the three layers. The endoderm tube becomes connected with the hind-gut invagination. The liver lobes are developed, and the mid-gut acquires floor, sides, and roof.

3. *Mesoderm and vascular system.*—After the differentiation of the endoderm, the mesoderm begins to be differentiated. It remains longer than the other layers below the germinal disc, and is last in growing dorsally over the embryo. The number of mesoderm segments represents that of the body. There is also a preoral segment with a cavity like the rest. The somatic layer is much thicker than the splanchnic. They pass into one another peripherally, and form on the margins of the body a complete unsplit layer.

The lateral margins of the mesoderm extend dorsally between ectoderm

* Biol. Centralbl., vi. (1886) pp. 525-32.

and endoderm, in a still unsplit layer. The marginal cells separate off from the others; those nearer the back become round, sappy, and transparent, like young ova. They move dorsally, and are the primitive blood-corpuscles. They occupy a long broad cleft, which becomes narrowed by the extension of the lateral mesoderm layers, which finally meet and fuse, first dorsally, and after a while also next the endoderm. A mesocardium is thus formed. The heart exhibits an inner endothelium and an outer muscular sheath. The valves also appear. The alary muscles are also mesodermic. Round the heart, especially dorsally, large cells accumulate and appear to form the pericardial membrane.

4. *The nervous system.*—The first traces appear, when the head appendages become demonstrable, as ectodermic thickenings in the median ventral line. Each joint of the body exhibits two elevations, (*a*) peripheral, forming the appendages, and (*b*) median, forming a segment of the nerve-cord. The ectodermal cells forming the nerve-strand proliferate, forming in so doing peculiar pits or hollow cavities, which gradually disappear. After considerable development, the fibrous substance becomes differentiated, and the ganglia are then separated from the ectoderm.

The cephalic nervous plate exhibits a paired hemispherical depression. This insinking is surrounded by a ridge. The sunk portions form the two cerebral masses, which remain for a while connected with the exterior by a cleft. Above the closure a new elevation is formed, and two pouches are produced, the first hints of the median eyes. In the sunk portion of the nerve-plate which forms the brain, the formation of pits, characteristic of the rest of the nervous development, is observed.

The median eyes arise from the same primitive nerve-plate as the brain. The peripheral portions of the fold associated with the development of the latter form two lateral pouches. These two folds approach and meet medianly, and when they meet the eyes are developed. The lateral eyes have an entirely independent origin.

5. *The coxal gland* was seen, when the nerve-cord had been separated from the ectoderm, as a paired tube, opening at the base of the second (?) pair of feet, and reaching internally to the anterior lobes of the liver.

6. *The genital ducts* were formed (*a*) from an internal funnel-shaped tube developed from the splanchnic layer, and opening into the body-cavity, and (*b*) from an external invagination forming the outer portion of the ducts.

7. *The pulmonary sacs* were first seen as simple invaginations of a space rich in blood-elements.

Microtelyphonidæ.*—In connection with his studies on primitive insect and myriopod forms, Prof. B. Grassi has described the anatomy and histology of *Kœnenia mirabilis*, representative of a new order *Microtelyphonidæ*, and forming the much desiderated intermediate form between Gigantostraca and Arthrogastra. The Microtelyphonidæ have lost the branchiæ, but have not yet acquired organs of aerial respiration. Prof. Grassi gives a comparative survey of primitive Arachnid orders.

ε. Crustacea.

Development of the Crayfish.†—Dr. H. Reichenbach has completed his memoir on the development of the crayfish, which he began almost ten years ago. His results are contained in a handsome monograph of about

* Bull. Soc. Entomol. Ital., xviii. (1886) pp. 153–72.

† Abhandl. Senckenberg. Naturf. Ges., xiv. (1886) pp. 1–137 (14 pls.).

140 pages, and are accompanied by drawings, partly due to Herr W. Winter, which exhibit unusual skill and care.

I. *Blastoderm and germinal layers.*—(1) The *egg-membranes* round the blastosphere are first described. The firm and tense chorion, the delicate blastoderm membrane, and a third structure covering part of the external surface of the chorion are noted in detail. The *contents* exhibited numerous oil-globules, yolk-pyramids, and small white yolk-elements. The central body found in the yolk is regarded as a residue of the undivided yolk. The blastoderm extends all over the yolk and is not, as Ratke supposed, confined to one region. (2) *Germinal layers*, &c. In stage A the embryo is an approximately spherical closed sac of a single layer of cells except in one region. The centre of gravity is in the hemisphere opposite the ventral plate, and thus the latter lies uppermost. The anterior region of the ventral plate exhibits the head-lappets with cells arranged in definitely concentric curves. The central portion exhibits the beginning of the ocular invagination, and the crystalline-cone-cells were also detected. Posteriorly the thoracico-abdominal rudiments were seen, and behind these a fifth large cell-plate—the endoderm disc. The mesoderm first appears at the anterior region of the endoderm plate. Stage B is characterized by the semicircular gastral groove on the endoderm plate, and this in stage C becomes annular. The mouth of the gastrula is primitively a circular, and afterwards an oval aperture with the narrower portion situated anteriorly. The formation of the primitive mouth varies considerably, and in this something more than intensity of cell growth and consequent pressures must be regarded as influential. The mesoderm developes at the passage of outer into inner layer at the anterior margin of the primitive mouth. In stage D the ventral plate is heart-shaped, and the primitive mouth becomes closed. The embryonic rudiment becomes considerably reduced both in length and breadth. The head-lobes and eye-rudiments have approached one another in the middle, and the thoracico-abdominal plates are united medianly. Reichenbach lays considerable emphasis on the differentiation of the mesoderm into primary and secondary. He describes how the endoderm cells devour the yolk-elements. (3) *General.* The third chapter contains a useful comparative survey of the relative literature. Reichenbach also calls special attention to the regular curves in which the cells of the embryo are disposed, as the beautiful plates so well illustrate.

II. *Body-form and systems of Organs.*—After describing at length the features of the embryo when the three nauplius appendages are distinctly apparent, the author gives a detailed account of the next five stages—(*g*) with developed masticatory appendages, (*h*) with developed walking limbs, (*j*) with abdominal appendages, (*k*) with well-developed eye-pigment, and lastly (*l*) the liberated embryo. Of these modifications it is hardly possible to give any brief account.

Derivatives of the ectoderm.—(1) The history of the external skin is first described. Particular attention is directed to the internal prolongations which serve, along with certain mesoderm elements, for the insertion of muscles, for sinews, supporting beams, &c. In the section of the carapace the interstices contain large wandering cells with yolk-like contents. (2) *The nervous system.* In the four head-segments of the nauplius, four pairs of ganglionic pads appear as ectodermal thickenings; of these the two last are separated by a shallow median furrow, which extends to the budding zone of the thoracico-abdominal rudiment. The first pair of ganglionic rudiments belong to the eye, the second and third form the brain, the fourth the ventral cord. The development is thence described at great length. From the very earliest stages the large ganglionic cells

of the central nervous system are recognizable, arising in the outermost ectodermic layer. A brief account of the histology of the system is also communicated. Herr Reichenbach maintains very strongly the primitive connection between the nervous system and the other organs. The separation is a subsequent differentiation. Green-gland and third ganglionic mass, eye and brain, &c., are primitively united. (3) *The eye and ear.* The eye results from three factors, (i.) epidermal, (ii.) an ectodermic invagination or eye-fold, (iii.) an optic ganglion. The epidermal layer appears very early, rising on the head-lobe like an appendage, at first with a single layer, afterwards with four or five. Its elements gather in groups of eight elongated cells. Four of these become closely united and form the peripheral covering and cuticular corneal facets. They are called Semper's cells. The other four are the mother-cells of the crystalline cones, which they form peripherally, while their inner processes are prolonged inwards to unite finally with portions of the eye-fold. The other cells of the epidermal layer become the pigment-sheaths of the individual eyes. The eye-fold appears as a flat groove on the head-lobes, is deeply invaginated in the nauplius stage, and forms a solid mass of cells. It soon forms two compact and complicated balls of cells, with the eye-fold long persisting between them. The peripheral ball becomes united to the processes of the crystalline cones; its elements arrange themselves radially, become grouped in sixes or eights, and form the retinula-cells, which form internally the layer of rods. The inner ball comes into intimate connection with the outer and with the optic ganglion. The third factor or optic ganglion arises in the nauplius stage as an ectodermal thickening in the optic segment, in direct contact with the brain and the eye-fold. Its details are then described. Reichenbach emphasizes the analogy between the Arthropod and Vertebrate eye-development. The invagination which forms the auditory sac appears in the embryo with incipient abdominal feet, but is not, of course, differentiated till afterwards. (4) *The gills.* Ratke's results are simply confirmed. (5) *The green-gland* appears in the stage with incipient walking legs as an invaginated sac on the basal joint of the second antennæ. Its history is briefly traced through a few phases. (6) *The hind-gut* arises in front of the closure of the blastopore as an ectodermic invagination. Herr Reichenbach gives a brief account of its slight changes, and of (7) the greater modifications of the *fore-gut.*

Derivatives of the endoderm.—In this chapter Herr Reichenbach traces the endoderm from the circular disc sunk into the yolk and forming a closed sac, to its final differentiation into mid-gut and liver. He devotes special attention to the relation of the endoderm to the yolk, e. g. in relation to the appearances known as secondary yolk-pyramids. The usual bibliographic review closes the chapter.

Derivatives of the mesoderm.—The *heart* is seen pulsating in the stage with incipient walking legs. It lies under an arched portion of the ectoderm which previously exhibited an accumulation of large loose mesoderm-cells. This mesodermic rudiment is symmetrical; the loose elements unite to form the ventral wall, whence the sides grow up and meet dorsally. The pericardium and mooring strands soon appear, and at a very early stage the wall of the heart exhibits two layers. The *blood-vessels* also arise from wandering mesoderm-cells, which form strands, by-and-bye exhibiting a lumen. The component cells are very small and flat. The development of the main vessels is briefly noted. The *blood-sinuses* are morphologically persistent portions of the primitive segmentation cavity, as indeed are also the cavities of heart and vessels. The elements of plasma or blood-serum are primarily mesodermic, probably plus additional migrations from

the endoderm. In discussing the *musculature*, Reichenbach raises the problem of the origin of the body-cavity, and notes especially that the mesoderm-cells in the abdomen are congregated in masses representing the segments, and that these exhibit a lumen, apparently progressive from before backwards. This certainly appears at a late stage, but seems comparable with the segmented body-cavity of related types. Finally the author was able to find after prolonged search what seemed to be the first rudiments of the reproductive organs, but was unable to determine from what layer they originated.

Eyes of Crustacea.*—Mr. W. Patten gives an account of the structure of the eyes of several Crustacea, and especially of those of *Penæus*.

(*a*) The *cornea* is divided into square facets, and consists of two layers. Below the cornea is a thin, continuous layer—the *corneal hypodermis*—to which the corneal cuticle owes its origin. (*b*) Beneath this is the much thicker *ommateal hypodermis*, of numerous *ommatidia* each consisting of 19 or 20 very long cells, extending down to the basal membrane. They are arranged in four circles, and the nuclei of each group are at the same level, in specially enlarged or pigmented portions. (*c*) The innermost group consists of four colourless cells—the *retinophoræ*, forming an inverted pyramid. The outer ends of the retinophoræ are thickened and contain the nuclei; below the nuclei the cells are filled with a mass of less consistent, finely granular protoplasm; then follow the conical, four-cornered *crystalline cones*, which are nearly half as long as the ommatidia themselves. The narrowing apex of each of these square pyramids is reduced to the slender, tube-like "*style*." The final expanded solid portion forms the rhabdom or *pedicel*. Near the basal membrane, the latter diverges into three legs composed of the attenuated, inner ends of the four retinophoræ, two of which have united. Each leg of the stalk is divided at its inner end into several fibres by which it is united to the basal membrane. The segments of the so-called rhabdoms of Grenacher are not secretions of the *retinulæ* (or pigmented cover-cells), but the inner ends of the retinophoræ, which terminate in the same root-like fibres as occur in nearly all hypodermic cells.

(*d*) After giving an account of the complicated structure of the pedicels, Patten passes to the *retinulæ*. Seven of these oddly-shaped, pigmented cells surround the retinophoræ. The outer parts of the retinulæ seem to terminate with the knob-like swellings containing the nuclei, but they are really continued onwards as extremely delicate membranes. These form a sheath round the style, though this is not always evident. The pigmentation and relations of the retinulæ are described in detail. (*e*) The pigmented collar of the retinophoræ is formed by a third circle of four cells in two pairs. The cells are continued inward to the basal membrane as slender colourless rods or bacilli, and outwards to the surface of the ommatidium, as four delicate fibres, producing four minute impressions at each corner of a corneal facet. The cell-stalks or bacilli, which are fastened by root-like fibres to the basement membrane, are elongated, hyaline fibres, with node-like thickenings at intervals. It is striking that these prominent and simple structures have hitherto remained unobserved. In the spaces between the diminished inner ends of the ommatidia is a third group of cells, ensheathing the inner ends of the retinulæ. They contain a mass of yellowish, fat-like crystals.

(*f*) The *basal membrane* is extremely complicated. It consists of connective tissue fibres, sometimes fused to form hyaline masses, connected

* MT. Zool. Stat. Neapel, vi. (1886) pp. 542–756 (5 pls.). Cf. Mollusca, *supra*, p. 53.

by a network of fine fibres. After noting the disposition of the fibres, Patten describes the arrangement of the ommateal cells on the membrane, and the bundles of nerve-fibres by which it is penetrated. The investigation is extended to *Galathea*, *Palæmon*, *Pagurus*, *Branchipus*, *Orchestia*, and to *Mantis religiosa*. Instead of following these, however, it will be more useful to summarize the author's general remarks upon Arthropods.

General.—The compound Arthropod eye consists of a double layer of cells, the ommateum and the corneal hypodermis. The latter always gives rise to the corneal facets. Just as in Mollusca, the evaginate, convex arrangement of the ommatidia has resulted in the expansion of the outer ends of the latter, and a reduction of the retinulæ to protective purposes, as in Arthropods. The retinophoræ of each ommatidium form four equivalent cells. "The terminal, cuticular secretions, or rods, are transferred to the axial faces of the outer ends of the retinophoræ; they there unite to form the crystalline cones, to accommodate which the outer ends of the retinophoræ are enlarged into a cup-like expansion—the calyx, while their inner ends are reduced to a slender tube, or style, serving at once as a support for the calyx, and as a protective canal for the axial nerve. Reasons are given for regarding the pedicel as a reflector. The convexity of the eye is a solution of the problem of arranging the layer in the most economic manner. The greater the number of ommatidia, the greater the curvature of the surface and depth of the layer. The colourless cells are the essential elements, the retinulæ have not, as Grenacher supposed, anything to do with the formation of the "rhabdom," which is formed by the continuations of the crystalline ones. The crystalline cone-cells are the essential elements, both morphologically and physiologically.

After a discussion of relative observations, Patten comes to the following general conclusions:—(1) "That the ancestral forms of all Arthropods were probably provided with a small number of eyes placed on each side of the head; (2) these eyes consisted of closed optic vesicles formed by invaginations lying close beneath the hypodermis, which formed a continuous layer over them; (3) the deep wall of the vesicle formed a retineum, similar to that of worms and certain molluscs, composed of colourless double retinophoræ, bearing terminal rods and containing an axial nerve-fibre; each retinophora was surrounded by circles of rodless pigment-cells; (4) the outer wall of the optic vesicle secreted a cuticular vitreous body, similar to that found in the optic vesicle of worms (Alciopidæ) and molluscs (*Fissurella*, &c.); (5) the hypodermis overlying the optic vesicle (corneal hypodermis) gave rise to a lenticular thickening of the cuticula, the lens." Modification has been in two directions: (1) an increase in the number of ocelli, with a decrease in the number of their ommatidia, or a decrease in the number of ocelli with an increase in the number and complexity of the ommatidia.

The eyes of *Euphausia*, &c., are briefly described, and the development of Arthropod eyes is briefly discussed. Müller's theory of mosaic vision, as advocated by Grenacher, is subjected to searching criticism and rejected. Morphologically, the seat of vision ought to be in the crystalline cones, the necessary nerves are only to be found in the crystalline cones, and finally the most perfect optical conditions are obtained in the crystalline cones, therefore the cones are the percipient elements. In eyes with lenticulate facets, an inverted image of those objects lying within the axis of the ommatidia will be formed upon the crystalline cone. In *Musca* or in *Mantis*, for instance, "there is absolutely nothing to prevent the formation of a perfect image, not upon one or two nerve-fibres whose surface is in no wise proportional to the size of the image, but upon a complete and

perfect series of fibrillæ, whose extension in all three directions is sufficient to receive the whole of any image formed by the corneal lens. The lack of focal accommodation in the lens is balanced by the depth of the retinidium. The theory of vision is discussed in some detail.

An interesting survey of other groups is given, showing how the above view of the structure of the molluscan and arthropod eye unifies that of all the groups. Another chapter is devoted to a development of the idea of a "Funktionswechsel" in the development of sense-organs, and especially eyes which were, according to Patten, not primitively perceptive, but absorptive of solar energy, *heliophagous*. Lastly, we repeat the author's classification of eyes:—

OMMATIDIA.

I. Ommatidia diffuse.
- A. Chromatophores (modified ommatidia): Cœlenterates (?), Molluscs, Crustacea (?)
- B. Isolated ommatidia: (universal ?)

II. Ommatidia aggregate.
- A. Ommatidial tracts: retinidial cuticula, thin; no rods developed — (Mollusca).
- B. Pseudo-lenticulate: ommatidial tracts, non-invaginate, or but slightly so; rods form a lens-shaped, unprotected protuberance — *Arca* and Cœlenterates.
- C. Invaginate
  - (*a*) retineum:
    - (1) primary: optic caps or vesicles; corneal cuticula forms a vitreous body ± primary lens — Cœlenterates, Molluscs, Worms.
    - (2) secondary: optic vesicles; triploblastic; vitreous body ± primary * or secondary lenses — Arthropod-ocelli. Stemma.
  - (*b*) retina: optic vesicles; anterior wall forms the retina; triploblastic; cellular lens — *Pecten* and Vertebrates.
  - (*c*) ommateum: optic vesicles; cuticular lens, single and secondary — Spiders, *Scorpio*, *Limulus*.
- D. Evaginate; ommateum,
  - (1) monoblastic: corneal cuticula present, but no lens is formed. — *Arca*, *Pectunculus*.
  - (2) diploblastic: a modified optic vesicle; corneal cuticula present, forming no lens or many. — Compound eye of Insects and Crustacea.

Development of Compound Eye of Crangon.†—Dr. J. S. Kingsley gives a preliminary notice of his investigations into the development of the compound eye of *Crangon*, in which it is shown to arise from a single

* A primary cuticular lens is one formed by the corneal cuticula within the optic vesicle; a secondary one is formed by the cuticula of the hypodermis overlying the optic vesicle.

† Zool. Anzeig., ix. (1886) pp. 597-600.

invaginated pit; this fact proves that the compound eye is not to be regarded as derived from coalesced ocelli; similar observations have been made by Sedgwick on *Peripatus* and by Locy on spiders, while Bobretzky and Reichenbach saw, but misunderstood the nature of, the pit. There is nothing in the development of the eye of *Crangon* which warrants the assumption that it or its stalk is an appendage homodynamous with the other appendages. The author sides with Patten in his criticisms on Grenacher's account of the structure of the eye of the adult Decapod; he thinks that the comparisons between the eyes of Arthropods and those of Vertebrates "are not so absurd as they would have seemed a year ago."

Crustacean Carapace.*—Dr. H. Ayers has recently † restated the theory and collected the evidence that the carapace is *not* the fused terga of the head and thorax, as it is usually stated to be, but that it is in reality the coalesced terga of the antennal and mandibulary somites, and that the "cervical suture," instead of being the line of separation between head and thorax, indicates the junction of these somites. The "episterna" of Milne Edwards are really portions of the sternum cut off by false sutures.

Abnormal Limbs of Crustacea.‡—Prof. E. Duns describes certain abnormalities in the thoracic appendages of *Carcinus mænas*, *Cancer pagurus*, and *Nephrops norvegicus*. In the two former the abnormality consists of a bifid or trifid character assumed by the terminal joint of one or more of the appendages, more noticeably the chelæ; accompanied in one case by an elongation of the three terminal joints. In *Nephrops*, the protopodite of the chela, which should be produced so as to form, with the dactylopodite, a claw, is not so produced. He considers it probable that these abnormalities are due to the injury of the soft parts just after an ecdysis. It is noteworthy that the mutilation occurs more often on the left than on the right side.

Mimonectes, a new genus of Amphipoda Hyperidea.§—Mr. C. Bovallius remarks that the genus now described by him appears to afford the first example of mimicry among the Amphipoda. The enormous globular development of its body gives it a striking resemblance to a little jellyfish, the straight slender legs and the minute tail hanging down as filaments. The new family—Mimonectidæ—to be formed for its reception, may be defined as "Hyperids with the head and a part or the whole of the pereion developed into an enormous balloon-shaped globe. Ocelli not united but dispersed on each side of the head. The upper antennæ long, more or less straight; the lower small, four-jointed. The mandibles without palp. The maxillipeds well developed." The interior of the pereion forms a bladder containing a fluid. Three species are described—*M. Loveni*, *M. sphæricus*, and *M. Steenstrupii*—which were all found in the Atlantic. Under the first form the author enters into full details of the anatomy, and especially of the nervous system.

The Genus Entione.‖—MM. A. Giard and J. Bonnier agree with Kossmann in distinguishing the *Entoniscus*-parasites of the Porcellanidæ from those of the Crabs, to which the name *Entione* should be applied. Almost all the species of crabs found on the French coast seem to have a special species of *Entione*, and these appear to be referable to a number

* Amer. Natural., xx. (1886) p. 978.
† Bull. Essex (U.S.A.) Inst., xvii. (1886) pp. 49–59 (2 pls.).
‡ Proc. R. Phys. Soc. Edin., ix. (1886) pp. 75–8 (1 pl.).
§ Nova Acta Soc. Upsala, xiii. (1886) No. 4, 15 pp. (3 pls.).
‖ Comptes Rendus, ciii. (1886) pp. 645–7.

of subgenera parallel with the crustacean genera on which they live. The authors distinguish *Grapsion*, *Portunion*, and *Cancrion*, and give some further notes on the third of these.

The study of the development of *Entione* is accompanied by many difficulties; it is certain that for a considerable time the embryos are free, and during this period it is difficult to follow their metamorphoses; they avoid light, and it is therefore to be presumed that crabs become infected during the night. From what the authors have been able to see, they conclude that the males of the different genera pass through a Cryptoniscus-stage.

Development of Copepoda.*—M. F. Urbanowicz has investigated the development of several species of *Cyclops*. The ovum undergoes total segmentation. One large sphere has its central extremity constricted off, to form a central cell of unknown destiny. The result of segmentation is a blastosphere containing nutritive yolk in the central cavity. The external cells divide radially and superficially. One specially large cell is invaginated and multiplies to form the ectoderm cells, while the slightly swollen internal extremities of ectoderm cells are constricted off to form the primary mesoderm cells. A stomodæum is formed by invagination, a mesoderm cleft forms the general cavity, and an endodermic cavity appears as the mesenteron. Meanwhile the embryo elongates slightly; the mesoderm cells are grouped dorsally to form three pair of muscle-bundles for the extremities; while ventral and anterior dorsal ectodermic thickenings form the ventral and dorsal ganglia, and apparently endodermic cells begin to form the typical secondary mesoderm.

When liberated, the larva exhibits no trace of segmentation, the two portions of the nervous system are still unconnected, the anus is not yet formed, &c. The appearance of the eye and kidney, and the development of muscle from amœboid mesoderm cells are then noted.

In the post-embryonic life the mesoderm bands increase in length, and the segments of the body are formed. The body-cavity is enterocœlous. The proctodæum is evident in a larva of thirty-six hours. In a nauplius of twelve hours lateral ectodermic thickenings unite the anterior part of the brain with the ventral ganglion, but the secondary posterior portion of the brain, bearing the eye, remains long separate. The growth of the double ventral nerve-cord is then described. The kidney atrophies after hatching. A pair of secondary kidneys appear in the second segment. The latter probably correspond to segmental organs, the provisional kidney to the analogous organ in the trochesphere larvæ of Annelids. The genital cells form an unpaired organ towards the dorsal surface of the larva. The shell-secreting dorsal organ is then noted.

Cypris and Melicerta.†—Mr. E. Roberts records an attack which he saw of a *Cypris* on a full-grown *Melicerta ringens*. The *Cypris* at first seemed to be digging its claws into the bottom of the tube, as if to tear it from the leaf; then it climbed up and scratched one side for some time, then the other, about half-way down, until there was a large hole in it. It then went to the bottom of the tube, and whilst there the *Melicerta* came out at the top and expanded its discs. The *Cypris* immediately climbed to the top, and the *Melicerta* as suddenly disappeared; and the former, with its head down and its claws stretched out, began to scratch the middle of the tube again, until part of it broke off, leaving half the *Melicerta* exposed. The *Cypris* then left it, and a number of minute, round, trans-

* Kosmos (Polish). 1885. Cf. Arch. Slav. de Biol., i. (1886) pp. 663-7.
† Sci.-Gossip, 1886, p. 259.

parent bodies appeared, which seemed to settle upon the *Melicerta* as it swayed backwards and forwards in its uncovered state. The next day the *Melicerta* was very lively, and was busy repairing its tube, as if nothing had happened.

New Parasitic Cymothoid.*—M. Z. Fiszer describes a new Cymothoid genus parasitic in the fresh-water fish *Idus Waleckii* (Dyb.) = *Cypricus lacustris* (Pall.). In structure it resembles *Livoneca sinuata* (Rochet); while in mode of life it approaches the Isopods, and especially *Rutoniscus*. It is a true parasite, not a commensal.

Vermes.

Origin of Annelids from the Larva of Lopadorhynchus.†—Herr N. Kleinenberg devotes the first chapter of his essay to observations on the germinal layers, in which he gives a critical account of the investigations on this subject. He is himself of opinion that mature Cœlenterates have no mesoderm, and that the median germinal layer of embryos of higher Metazoa is a mere conventional idea, which does not correspond to the fact. What has hitherto been called the mesoderm is either the sum of independent heterogeneous rudiments which arise within the primary germinal layer, or is a single rudiment of a definite tissue or of organs which eventually undergoes partial metamorphosis. As a rule, well-marked ectodermal muscle-rudiments and paired appendages of the archenteron are regarded as part of the median germinal layer. In every case the homology of organs must be established by their genetic relations to the two layers of the cœlenterate body. These layers give rise to special tissues which have no power of producing fresh tissues, and, on the other hand, the tissues and organs which arise directly from one of these layers are able to bring forth other tissues and organs; in no living part of the body is the internal force of metamorphosis completely lost. The genetic relation between any given organ and the primary germinal layer is not lost; it is only separated by the intercalation of one or more intermediate stages; none of these intermediate stages are represented by an indifferent germinal layer, but always by a tissue or organ with a specific activity. Thus, the permanent peritoneal investment of the enteron of *Lopadorhynchus* does not arise directly from the ectoderm, and still less from any other germinal layer, but from the metamorphosis of part of a quite specific rudimentary tissue—the muscular layer. The peritoneal epithelium consists of altered muscle-cells, and as the muscle-plates arise directly from the ectoderm, the latter are secondary and the former tertiary descendants of the ectoderm.

This mode of regarding the subject appears to open out a further field for embryological investigations; where an organ does not arise directly from a germinal layer, the nature of the permanent or temporary intermediate organ must first be settled, and in the second place we must investigate how far this genetic series is constant within one or more classes of animals. The removal of the mesoderm frees embryology of an embryonic constituent.

The second chapter deals with the development of the external body form of *Lopadorhynchus*, which is described in detail; the youngest larvæ found had an almost spherical form, which is divided into two equal halves by a completely closed circlet of cilia; the upper may be called the umbrella, the lower the subumbrella. Both ectoderm and endoderm are rather thick, and the latter incloses a spacious archenteric cavity. Large

* Kosmos (Polish), 1885, p. 458. Cf. Arch. Slav. de Biol., i. (1886) p. 466.
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 1–228 (16 pls.).

flagella become developed and work actively and rhythmically at first. The stomodæum after a time disappears, to make way for the definite mouth, which appears at the same spot as the external stomodæal orifice; its presence allows one to distinguish a ventral from a dorsal surface. Just below the stomodæum the ectoderm becomes again depressed in the middle line, and forms a narrow, short, blind tubule, which is directed obliquely inwards and downwards; its inner wall is covered by fine cilia, which appear to have a very complicated motor rhythm.

In the third chapter the author deals with the youngest larvæ, and in the fourth with the development of the various tissues; the fifth is a contribution to the theory of the neuromuscular system.

The larva of *Lopadorhynchus* in its simplest form—that is, when it commences to lead an independent free life, but is not yet laden with the extensive and numerous rudiments of the annelid organism—is an almost spherical body, sharply divided into an upper and a lower hemisphere. On the lower one lies the mouth formed by a stomodæum. The endoderm, and, for the greater part of its extent, the ectoderm, is a single uniform layer; between the two are a few contractile cells. In the prototroch, at the boundary of the two hemispheres, there is a special and proportionately rich organization—there is the locomotor organ, a simple ring of large cells, with strong cilia, with which is connected an upper and a lower row of smaller ciliated cells, a nervous system, and a circular muscle. The nervous system is composed of regularly disposed fibres and cells; the chief part of the fibres forms a closed ring, and the fibres are the processes of two kinds of ganglia, one of which is called automatic and the other reflex. At the point where, later on, the cephalic ganglion arises there are a few ganglionic cells, which are clearly not constituents of the larval system, in the way of formation.

The central nervous system of the larva of *Lopadorhynchus* may be regarded as consisting of a fairly diffused nervous plexus, the processes of which partly pass into other tissues, and so form the peripheral system. But, within this plexus, a further centralization is brought about, the closed system of the nervous ring being the controller of the whole system. Such a system is, as a permanent arrangement, found among the craspedote Medusæ, and there are essential resemblances between the two. The topographical relations of the margin of the umbrella with the velum, and of the prototroch with the general body are the same, and both are the chief organs of locomotion. Their contractile elements are, however, very different, in correspondence with the difference in their structure. If we suppose that the prototroch of the annelid is the homologue of the margin of the umbrella and velum of the medusa, then the Annelid-larva might be classified in or near the Hydro-medusæ, and the stem-form of the annelids is to be sought for in a form which stands much nearer the craspedote Medusæ than the hypothetical organism which Balfour took to be the originator of *Pilidium*, *Trochosphæra*, *Tornaria*, *Actinotrocha*, and the larvæ of Echinoderms and Brachiopoda.

Organogeny of the Hirudinea.*—Herr J. Nusbaum has studied in *Clepsine complanata* Jav. the later development of the Hirudinea. After referring to unfavourable technique the opinion of Hoffmann as to the absence of proper germinal layers, Nusbaum discusses, in the first place, (1) the development of *the body-cavity and of the muscular and connective tissue.* As in higher worms, each mesodermic band divides into 23 somites, in each of which a cavity appears. The replacement of the somite-spaces

* Arch. Slav. de Biol., i. (1886) pp. 320-40 (4 pls.) and pp. 539-56.

by the general body-cavity is described. The dorso-ventral muscles are mainly derived from the elements of the disintegrated partitions. The circular and longitudinal muscles and a large portion of the connective tissue are developed at the expense of the parietal layer of the mesoderm. The connective tissue which forms the sheath and support of the nervous system is formed from ectodermic elements, which at a less advanced phase appear as a thick mass in the anterior portion of the embryo. All the rest arises from the mesodermic elements which result from the disintegration of the somite walls.

2. *The alimentary canal.*—In regard to this point Hoffmann and Whitman have arrived at opposite results, the former deriving the digestive tube from the mesoderm, the latter from the primitive endoderm. Nusbaum has shown the correctness of Whitman's conclusion. Even the epithelium lining the cavity of the proboscis is of endodermic origin, and the posterior intestine has a similar history.

3. The *nephridia* appear as accumulations of mesoderm cells, as differentiations of the parietal sheath, in the anterior angle of each somite, abutting directly on the anterior septum. They appear in all the segments, but are reduced in the most posterior. Certain large reproductive cells are locally associated with their development. The appearance of the cavity and subsequent stages are carefully described.

4. *The reproductive organs.*—After giving a full account of the anatomy and histology of the reproductive organs, the author describes their development. Eight large endoderm cells at the posterior pole of the embryo (Whitman's "neuroblasts") multiply rapidly and extend forward until finally a pair are found in each segment. As the separate somites appear, the sex-cells are found disposed at the base of the septa. They multiply rapidly and form (1) a pair of cellular masses at the boundary between proboscis and mid-gut—the *ovaries*, and (2) six groups of *sperm cells* separated by lateral diverticula of the mid-gut. At the posterior portion of the proboscis, isolated free-cells are formed, probably reduced yolk-forming cells, as in *Amphilina-Planaria* for instance. The young ovaries are solid rounded masses with characteristic cells, they are surrounded by a mesodermic endothelium. They become associated with a pair of nephridial rudiments, the expanded ends of which embrace the ovaries. The nephridium forms the oviduct, and external elements add muscle-fibres and outer membrane. Round each group of sperm cells a mesoderm endothelium is formed, and the delicate transverse canals connecting testes and vasa deferentia are formed from this envelope. The vasa deferentia represent a pair of modified nephridia. Further details of the development are given, and the free disposition of all the organs within the body-cavity is compared with what is permanent in *Gunda segmentata* and *Amphilina-Planaria.*

5. *The nervous system.*—In regard to the development of the nervous system in *Clepsine*, there has been a good deal of haziness. Nusbaum has shown its origin from a ventral ectodermic thickening forming the ventral cord, and an anterior dorsal forming the brain. The insinking of the cord is carefully described. At an early period isolated endodermic cells apply themselves to the surface of the cord, forming a sheath of flat cells—the internal neurilemma, but also sending prolongations between the elements of the nerve-cord and dividing it into three portions. These penetrating elements form a delicate network separating the cellular portion of the chain from the fibrillar. The author also notes the temporary connection of ventral blood-vessel and nerve-cord. Anteriorly the wall of the ventral vessel is seen to be prolonged into two lateral plates, which unite

directly with the membrane, separating the cellular from the fibrillar portion of the cord. Posteriorly the vessel is quite isolated, and the anterior association afterwards disappears; but there seems thus to be a special provision for nourishing the nervous system during its development.

6. *Vascular system.*—By arrangement of the dorso-ventral muscles two longitudinal partitions are formed in the body. The ovoid median *sinus* thus formed contains the nervous system, the ovaries, the two blood-vessels, the anterior and posterior portions of the mid-gut. The lateral prolongations of the digestive system and the testes lie in the marginal sinuses. The dorsal and ventral *vessels* are very different. Two solid cellular strands are formed along the alimentary tube, the one in the median ventral, the other in the median dorsal line. Both seem to arise from the splanchnic layer of the mesoderm. Each strand is differentiated into a central cord, and an external layer separated from the former by a delicate structureless membrane. The external layer forms the wall of the blood-vessel, the central strand forms the elements within.

7. *A temporary dorsal organ* is for the first time noted. It lies in the dorsal middle line, in the anterior third, and consists of a canal running into an external prominence from which long delicate threads are emitted, probably for fixing purposes.

8. *General conclusions.*—Nusbaum notes the accordance of his results with those of Salensky on *Branchiobdella*, and compares his conclusions with those of others. As to the position of the Hirudinea, his embryological results lead him strongly to maintain Balfour's opinion that they were slightly degenerate Annelids, near allies of the Chætopods.

Colossal Nerve-fibres of the Earthworm.* — Prof. F. Leydig, after referring to the views of other anatomists, gives an account of his own re-examination of the colossal nerve-fibres of the ventral ganglionic chain of the earthworm. They may present a quite homogeneous interior, even after treatment with reagents, and, again, with certain hardening fluids such as chromic and acetic acid they may exhibit certain differentiations.

A band of granular axial substance is seen in transverse sections, in which the granules have an angular form, and it is possible to convince oneself that there is an extremely fine plexus, in which the dots are the nodal points. There is, therefore, a spongioplasm, in the meshes of which a hyaloplasm is contained.

It seems that, in transverse sections, the median or larger of the colossal fibres is divided by septa arising from the cortical layer into two halves, each of which has its own axial bands. This is clearly the commencement of what in other genera is the absolute division of the fibre into two tubes (e. g. *Stylaria*). Careful observation reveals the presence of intermediate stages between the ordinary and the colossal fibres; this is best seen in the region of the ganglia.

The author directs attention to the relations between the colossal fibres and what he has already taught as to the structure of the nerves of invertebrate animals. To understand thoroughly the nature of the colossal fibres it is necessary to extend investigations to the Arthropoda, where likewise there are colossal fibres, which are true elements of the nervous system.

Annelids of the Genus Dero.†—Mr. E. C. Bousfield points out that the species of *Dero* are distinguished from the *Naides* by the absence of eyes, of corpuscles from the perivisceral fluid, and by the termination of

* Zool. Anzeig., ix. (1886) pp. 591–7.

† Report Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1097–8.

the body in a wide membranous expansion bearing four branchial processes. This last is highly contractile, owing to the presence of numerous stellate muscle-cells between the respiratory and epidermal walls; the blood-vessels are here also much modified, the abdominal vessel dividing at its termination into two branches, which run round the area, giving off one looped branch to each branchial process, and also branches which cross the area obliquely. There are never more than four processes arising from the floor of the area, but there may be also two smaller marginal processes. Eight species are enumerated, and the characters of their respiratory processes distinguished and indicated.

Budding in Oligochæta.*—Prof. A. G. Bourne finds that there are variations in the mode of budding in different genera and species of Oligochæta. He has made an exact study of *Nais* (*Stylaria*) *proboscidea*, and finds that when budding is about to commence there is a slight thickening of one of the septa which separate the cœlomic segments. This thickening increases, the body-wall in the region thickens, and an actual budding region is formed. This new region elongates and presents a solid appearance. The alimentary canal grows and is at first distinguished by its lighter colour. The budding region divides into two; the anterior portion developes numerous setæ, and gives rise to an indefinite number of segments which form the tail of the old worm; the posterior portion developes four pairs of ventral setæ. The characteristic proboscis being developed, the two individuals separate. The budding region usually appears between the twenty-fifth and twenty-sixth segments, so that the twenty-sixth segment of the parent becomes the fifth segment of the daughter, the four anterior segments never presenting dorsal setæ, and being in all individuals modified (or cephalized).

Excretory and Generative Organs of Priapulidæ.†—Dr. H. Schauinsland describes the as yet unknown excretory or generative organs of the Priapulidæ. The tubes that open with the anus are primitively the efferent parts of the excretory organ, and they only secondarily take on a generative function. From these tubes small canals extend into the cœlom; these soon branch and form the excretory apparatus. The terminal organs or true secreting parts consist of small pyriform cells, each of which has one extremely long flagellum which projects into the excretory canaliculus, and keeps up an active motion; in its region the canaliculi are non-ciliated, but on the rest of their course the cells that line them have a few short cilia. The excretory cells may be compared with those of Platyhelminthes. When the production of ova and sperm commences the two tubes begin first to form small folds, which grow into the attaching mesentery; from these there arise small tubes which in the female are generally unbranched, but in the male are a good deal ramified.

The generative products are developed from the epithelium of these tubes; the young cells, as soon as they are larger than the other epithelial cells, appear on the outer surface of the tube; as soon as they are mature they gradually return, and fall free into the lumen. The spermatozoa have an altogether similar history; they are at first distinguished from the neighbouring cells by the size of their nuclei. These products pass from the lumen directly to the exterior, and do not, therefore, as in other Gephyrea, first fall into the cœlom. In old animals the structure of the gonads is very complicated, owing to the conversion of the tubes into what look like flat lamellæ. The structure of the excretory organs and the

* Rep. Brit. Assoc. Adv. Sci. for 1885 (1886) pp. 1096–7.
† Zool. Anzeig., ix. (1886) pp. 574–7.

mode of formation of the genital products are in the Priapulidæ so different from what is seen in other Gephyrea, that they afford another reason for that rearrangement of the system of the class to which Hatschek has already directed attention.

Lymphatic System in Enchytræidæ.*—Dr. W. Michaelsen corroborates and extends what he has previously noted in the Chætopod Enchytræidæ as to the existence of vessels connecting the gut and the circulatory system. After giving diagnoses of *Buchholzia* and *Enchytræus tenuis*, he describes in detail the position of these connecting vessels. Between the intestinal epithelium and the circular muscles there is a blood-sinus divided into numerous intertwining and communicating canals. Between certain segments a system of fine canals can be detected penetrating the epithelium-cells—these are the chyle-vessels. The chyle passes into these, and thence by osmosis into the blood. Dr. Michaelsen describes analogous arrangements in various forms. The appendage to the gut in *Brada* is regarded as morphologically between the appendage in *Buchholzia appendiculata* and the "heart-body" of many Annelids. The former is lymphatic, the latter probably effects the purification of the blood, while the appendage of *Brada* is perhaps also physiologically between the two, serving both for the absorption of the nutritive juice and the separation of the useless components.

Oogenesis in Ascaris.†—The phenomena of maturation in the ova of *Ascaris megalocephala*, so recently investigated by Nussbaum and by van Beneden, have now been observed by Prof. J. B. Carnoy. As the two former authorities differed, so Carnoy from both. The memoir is very handsomely got up—quite an *édition de luxe*, with its large print, wide margins, tabular summaries, and magnificent plates.

Carnoy's principal observations are thus summed up. In *Ascaris megalocephala*, (*a*) the typical nuclein element divides early into eight approximately equal stumps, which separate immediately into two groups of four, disposed laterally with respect to the axis of the future spindle, and forming the two germinal spots. (*b*) These are motionless during subsequent development and maturation. (*c*) At the entrance of the sperm, sometimes sooner, sometimes later, the germinal vesicle begins to move, and bursts its membrane; a karyokinetic figure appears with a halved spindle and with associated asters of various orders and degrees of complexity. The germinal spots remain equatorially, each on half a spindle, without change or division. (*d*) At the surface the figure dislocates and divides, or remains intact, and disappears into ordinary cytoplasm, in which the two germinal spots remain still intact. (*e*) Between the latter a new spindle appears, the spindle of separation, and at the same time the small rods often arrange themselves in a row. (*f*) Soon one of the spots is expelled with a variable portion of protoplasm, but without undergoing change; the other half remains also as it was. (*g*) From the latter a second figure arises, separated into two groups just as at first. These lie equatorially, and do not undergo fragmentation or any change. (*h*) The new figures are exactly like the old, halved up the middle, much elongated, and rich in asters. They too are resolved into ordinary cytoplasm. A new separation spindle appears, and one of the two groups is expelled. The survivor forms, of course, the final nucleus, and becomes provided with caryoplasma and a membrane. The memoir also contains a large number of more general notes on the problem of division.

* Arch. f. Mikr. Anat., xxviii. (1886) pp. 292-304 (1 pl.).
† La Cellule, ii. (1886) pp. 1-77 (4 pls.).

Nematoid Parasite on Sugar-cane.*— Dr. A. Treub has lately discovered on the roots of the sugar-cane in Java a nematoid parasite which he calls *Heterodera javanica*. Its general habit is analogous to that of *Anguillula tritici*, or of *Heterodera schachtii*. The small females penetrate into the main root through some cleft, or perhaps from the growing point. They settle down at some point where a secondary root is given off. This region is externally marked by a knot-like swelling due to the increased growth of surrounding cells. Treub does not state to what extent the parasite is hurtful.

Cysticercus cellulosæ in Brain of Man.† — The exception to the ordinary life-history of Cestodes, as expressed in the occurrence of *Tænia solium* and *Cysticercus cellulosæ* within the same human form, has always provoked some surprise. The experiments of Redon and the close anatomical resemblances have led Leuckart and other authorities to regard it as certain that the cystic form found in the brain of man was really the *Cysticercus cellulosæ* or the early stage of *Tænia solium*, and to explain its abnormal occurrence as due to self-infection in some form or other.

M. Adolphe Hannover questions this explanation and the postulate on which it is based. The simultaneous occurrence, if the result of self-infection, ought to be much more frequent than it is. The unusual position of the *Cysticercus*, when compared with that exhibited by those in other animals, e.g. pig, is also noteworthy. So, too, the peculiarities of form, and the extraordinary size, suggest to him something more than a mere physiological difference of environment. He has subjected the two forms of *Cysticercus* in man and in pig to a careful and detailed scrutiny, and though none of the differences chronicled are in themselves very noteworthy, the combined differences are suggestive, if not of M. Hannover's theory, then of the modifications of the same form in different surroundings.

Bothriocephalus latus in Belgium.‡—Prof. E. van Beneden has a careful discussion of the question of the existence in Belgium of this large human tapeworm; till lately, though found in Holland, it seems not to have attacked the Belgians. The author states that Prof. Leuckart thinks that railways, and the facility of communication which is their result, will lead to a gradual dissemination of parasites.

Scolex polymorphus.§—Dr. F. Zschokke considers that *Scolex polymorphus*, which is found in the intestine of various species of *Lophius*, *Gobius*, and other fishes, is the larva of some species of *Calliobothrum*. It has the rudiments of the four accessory suckers, and the central sucker; the muscles for moving the hooklets are present, and the excretory system is on the same type as in this form.

The author considers that Wagener's division of the scolices, according to the mono-, bi-, and tri-locular condition of the suckers, is unnatural; they are merely various stages in the development of one and the same larva.

The Diplostomidæ.‖—M. J. Poirier has examined *Diplostomum siamense*, *D. pseudostomum*, and *Polycotyle ornata* of W. Suhm (not Suhn as printed by the author). He finds that the genital orifices are not separately placed on the ventral surface of the lanceolate region of the body, but that they open into a common cloaca at the hinder end; the orifice ordinarily

* Naturforscher, xix. (1886) p. 401.
† Journ. de l'Anat. et de la Physiol., xxii. (1886) pp. 508–14.
‡ Bull. Acad. R. Sci. Belg., lv. (1886) pp. 265–80.
§ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 354–6.
‖ Arch. Zool. Expér. et Gén., iv. (1886) pp. 327–46 (3 pls.).

considered as that of the male duct is the opening of the sucker, and that which has been taken for the female orifice is that of a large cavity which is in relation to a large glandular mass. The digestive apparatus extends through the whole of the posterior cylindrical region, and the excretory apparatus is well developed. Save for the fact that the suckers are dorsal, *Polycotyle ornata* has all the characters of a Diplostomid, and should be placed in the family of the Diplostomidæ, and not, as Suhm thought, near the Polystomidæ.

Nemerteans of Roscoff.*—In August 1885 M. F. Chapuis collected at Roscoff thirty-five species of Nemerteans, among which *Cephalothrix viridis*, *Polia cæca*, *Lineus variegatus*, *Cerebratulus modestus* are new species; there is also a new variety of *Cerebratulus fasciatus* with the sides and lower surface white. *Tetrastemma diadema* differs in colour from the specimens described by Hubrecht.

Ova and Development of Rotatoria.†—Herr G. Tessin commences his essay with some notes on the female generative apparatus, and the formation and maturation of the ova, in which the observations of Plate are discussed and criticized; the somewhat irregular segmentation is next described, and gastrulation is found to be epibolic. The mesoderm apparently, but not really, arises from the ectoderm, and commences to be formed at the anterior end; the observations of Zacharias are traversed. The ectodermal cells are for a long time remarkable for the difference between the dorsal and primitively ventral cells; the cephalic region is exclusively formed of the small primitively dorsal cells, while the ectoderm of the trunk and tail is derived from three ventral ectodermal cells; what Salensky regarded as the central organ of the nervous system really gives rise to the pharynx and the wheel-organ. The first part of the nervous system to appear is the eye-spot, which marks the position of the brain. The endoderm has early the appearance of one small posterior and two larger anterior cells.

With regard to the systematic position of the Rotatoria, as to which so many very different propositions have been maintained, Herr Tessin remarks that they all agree in considering the adult organism to the exclusion of its mode of development. The peculiar mode of segmentation, and the fact that a part of the ectoderm long remains connected with the endoderm, while the mesoderm is early separated from the latter and connected with the ectoderm, appears to be a secondary change; the difference between them and other Bilateralia in the mode of origin of the mesoderm is only apparent. Gastrulation results in the appearance of a hypogastric bilateral form; the prostoma does not pass to one pole of the egg, but to what will be the ventral surface, and it marks the place of the definite mouth, which in all hypogastric Bilateralia arises either directly or indirectly from the prostoma. The further characteristic—of a transverse axis—is also developed. It seems, indeed, to be certain that the Rotatoria must be regarded as true hypogastric Bilateralia.

With regard to their relationship to the Annelida—a view which has been based by Hatschek on his well-known trochophore stage—the author objects to the homology instituted between the oral circlets of cilia in Rotatoria and the preoral and postoral ciliated circlets of the trochophore. When the development of the wheel-organ is studied, and its origin from an anterior ectodermic invagination (just like the tentacles of the Bryozoa)

* Arch. Zool. Expér. et Gén., iv. (1886) pp. xxi.–iv.
† Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 273–302 (2 pls.).

is borne in mind, it is impossible to homologize it with the circlets of worms. In the latter the preoral circlet surrounds the frontal area, and within it the brain arises; but in the Rotatoria the brain always lies outside the wheel-organ, which does not inclose the frontal area.

The lobate structures which are found round the mouth of all rotatorian larvæ appear to the author to be remnants of the largely developed lobate appendages of turbellarian larvæ.

Although there are close anatomical resemblances between the excretory organs of worms and Rotifers, they must not be supposed to have arisen in the latter from the former; the point of union between Annelids and Rotifers must be sought for deeper down in the scale of animal organization—in the Turbellaria.

The mode of origin of the mesoderm opposes the view that Annelids and Rotatoria are closely allied, for in the latter it arises at the anterior lip of the prostoma, and in all the former at the hinder end of the body; the mesoderm of Rotatoria can only have been developed from a not yet definitely localized mode of formation of the mesoderm, such as obtains among the Turbellaria.

With regard to an affinity between the Rotatoria and the Crustacea, the mode of origin of the mesoderm offers some support; the reduction of the postabdomen is another point of similarity, as is also the dorsal position of the anus. The jointing and forking of the same region recalls the Copepoda, and seems to be an important characteristic. The absence of a ventral medulla is against crustacean as well as annelidan affinities.

The author thinks he has justified the removal of the Rotatoria from the "class of worms," and ascribes to them a position intermediate between the lower worms and the lower crustaceans. In the system they must form a special division between Vermes and Crustacea.

Natural History of Orthonectida.*—M. R. Köhler finds that *Rhopalura* is found rather more abundantly in those Ophiurids which dwell among the tubes of *Serpula Philippii* than in those which live quite freely. Parasites are rarely found in specimens that have been in glasses for some days. Both males and females were frequently found in the same Ophiurid, and the males are always more abundant than the females. Contrary to the observations of Julin, the author failed to find that the season had any modifying influence on the proportion of the sexes.

Two New Species of Balanoglossus.†—Prof. A. F. Marion gives a detailed account of the two new species of *Balanoglossus*, whose characters were indicated in a note already referred to in this Journal.‡ Information is now given as to the results of an examination of transverse sections, as to which the author is very detailed, but he abstains from any generalizations.

Cœlenterata.

Polypes turned outside in.§—Herr M. Nussbaum gives an account of experiments on *Hydra*, in which he tested the often-repeated assertion, based on the authority of Trembley, that in a *Hydra* turned outside in, ectoderm became endoderm, and endoderm ectoderm, and all was again in *statu quo*. This is not the case. After a time, according to Nussbaum,

* Comptes Rendus, ciii. (1886) pp. 608–10.
† Arch. Zool. Expér. et Gén., iv. (1886) pp. 305–26 (2 pls.).
‡ See this Journal, 1886, p. 252.
§ Biol. Centralbl., vi. (1886) pp. 570–2. (Ber. 59 Versamml. Deutsch. Naturf. u. Aertze, Berlin, 1886).

an outer ectoderm is, indeed, recognizable, but this originates, not by the modification of the everted ectoderm, but as a growth from the tentacles and basal pore.

His further experiments led him to these three conclusions:—(1) That the nature of tissues is constant, ectoderm is always ectoderm, and cannot become endoderm; (2) that for reconstruction of the whole from a part, that part must contain representative portions of all three layers; (3) that the artificial division of Protozoa and Polypes lends support to the theory of heredity suggested by Jäger, clearly enunciated by Nussbaum, and recently developed by Weismann—the theory of the continuity of the germinal protoplasm.

Structure and Development of Siphonophora.*—Prof. C. Chun finds that the most common Siphonophore of the Mediterranean has never been properly recognized; he gives it the name of *Diphyes subtilis;* its *Eudoxia*-stage was known to Will, who applied to it the name of *Ersæa elongata.* The author gives a table showing the relation of the *Eudoxia*-stage to five Mediterranean Calycophorids:—

1. *Cuboides vitreus* (?) Quoy and Gaimard *Eudoxia cuboides* Leuckart	*Abyla pentagona* Eschscholtz.
2. *Eudoxia messanensis* Gegenbaur .. .. *E. campanula* Leuckart	*Diphyes acuminata* Leuckart.
3. *Ersæa truncata* Will .. .. *Diplophysa inermis* Gegenbaur	*Monophyes gracilis* Claus.
4. *Ersæa pyramidalis* Will .. .. .. *Eudoxia eschscholtzii* Busch	*Muggiæa Kochii* Chun.
5. *Ersæa elongata* Will	*Diphyes subtilis* Chun.

The author doubts the production of *Eudoxia*-stages in any other of the well-known Diphyids of the Mediterranean.

Structure of Eleutheria.† — Dr. C. Hartlaub has a preliminary notice on this small creeping Cladonemid; it has a bell-cavity of the normal width, which is bounded below by a broad velum. Below the zone of tentacles the side wall of the cavity is formed by a well-developed urticating ridge. The brood-cavity is placed on the dorsal side of the animal, and is not the homologue of the canal of the manubrium of the medusa bud, for it has no communication with the gastric cavity; it is invested by a special epithelium, and is connected with the bell-cavity by six interradial canals. It is hermaphrodite, and its sexual cells are developed from the epithelium of the brood-cavity, the female cells ventrally, and the male dorsally.

The bell, in the ordinary sense of the word, is rudimentary, the radial canals being extraordinarily short, and the peripheral part very delicate. The urticating ridge reminds us of the same parts in the Trachynemidæ and Geryonidæ, but is distinguished by the fact that it consists of an inner layer which carries the stinging cells, and an investing epithelium, which, to guess from the figures given by the Hertwigs, is wanting in the first-mentioned forms. The velum, the presence of which has been hitherto denied, is very broad, and may almost completely close the bell-cavity; the bell-wall does not serve as a propelling organ, but for a support and brood pouch.

The author was able to convince himself of the hermaphrodite nature of this remarkable medusoid by means of a series of sections made on fortunately selected examples; only twelve per cent. were found to be

* SB. Preuss. Akad. Wiss., 1886, pp. 681–8. † Zool. Anzeig., ix. (1886) pp. 707–11.

hermaphrodite, the rest having female cells only. As some large forms were found without brood pouches, and a number of very small ones with the pouch well developed, the period of reproduction must either vary with individuals, or must be periodic.

Gastroblasta Raffaelei.*—Dr. A. Lang describes a remarkable craspedote medusa which he observed at Naples; almost all the individuals examined had more than one stomach and a varying number of apparently irregularly-arranged tentacles and radial canals; one large individual had nine gastric tubes; so that it appeared to him that he had before him a colony of medusæ formed by a kind of incomplete division.

The example just mentioned had its greatest disc-diameter 4, and its smallest 2·7 mm.; all the other examples were much smaller. The form taken for description had the disc slightly curved, the gelatinous substance poorly developed, the velum pretty broad and powerful. The outer circumference of the disc is not circular, but somewhat ellipsoidal; at the margin tentacles and tentacle-buds were found at various stages of development. Between them were ten auditory vesicles formed on the leptomedusan type. Of the four gastric tubes not one is central; each gave off a radial canal, which opened into the well-developed circular canal.

A study of the tentacles showed that the margin of the umbrella was divided by the four that were oldest into four quadrants of unequal size; the relative positions of the various tentacles is exactly stated. The ten auditory vesicles were found to be of various ages, and seem to appear much later than the tentacles; similarly the four radial canals were of different ages. The tentacles are hollow, and much thickened at their base; the urticating capsules are arranged in more or less distinct rings; in structure the tentacles resemble those of *Eucope* and *Phialidium*. The gastric tubes are unstalked, tubular, and capable of considerable enlargement; each is produced into a large quadrangular oval disc, which is very contractile; the wall of the stomach is very thick, and of the disc very thin. The constancy in the number of four gastric processes is the sole anatomical characteristic which points to the primitive quadriradiate structure of the Medusæ. New gastric tubes arise as outgrowths of the radial canals which project into the cavity of the subumbrella; and, on superficial examination, they may be mistaken for gonads.

Division is one of the means by which this remarkable form reproduces itself, and the plane of division is at right angles to the connecting vessel between the oldest and next oldest stomach, and is also at right angles to the longest diameter of the disc; the organs in each half correspond exactly in number, arrangement, and age-series, allowing, of course, for the fact that each half cannot have exactly the same parts; that is, if the right half be called *A*, and the left *B*, the oldest tentacle (*t*) of the mother becomes the oldest tentacle of *A*, the second oldest the oldest of *B*, the third oldest of the mother the second oldest of *A*, and so on. It is, in fact, possible to say of either to which half of the mother it corresponds.

The author next describes the metamorphosis of the daughter animal which arose by division; if the starting stage be that of the left half of the dividing medusa, the second stage is marked by the development of fresh tentacles and a new radial canal; in the third there is, *inter alia*, a new stomach developed, and in the fourth a fresh mouth. The result of all this is that the daughter is now exactly like the mother. There may be now a fresh fissure, in which the same phenomena as before are seen, or there may be further budding; in the latter case there may come to be 26 well-

* Jenaisch. Zeitschr. f. Naturwiss., xix. (1886) pp. 735–63 (2 pls.).

developed tentacles, about 17 rudiments of tentacles, 20 radial and centripetal canals, 9 completely developed and 7 rudimentary stomachs. Observations were made on the mode and order of development of the gonads; even the sexual forms may divide by fission.

The peculiarities of this remarkable form may be thus summed up:— 1. Existence of several gastric tubes. 2. Absence of a central stomach. 3. The budding, in obedience to quite definite laws, of new tentacles, marginal vesicles, radial canals, gastric tubes, and gonads on the radial canal. 4. Successive and regular right-angled divisions. 5. Variations in the age and size of homologous organs, and the complete absence of a radiate structure. 6. Adradial position of the tentacles, and interradial position of the marginal vesicles.

In conclusion, the author offers some speculations on the mode of origin of this form, into the details of which we have not space to follow him. If the Medusa had radiate larvæ like *Eucope*, which reproduced by successive rectangular divisions, in the way described by Davidoff, the series would necessarily give rise to irregular stages; Dr. Lang thinks that Davidoff's form was not *Phialidium variabile*, but the first stage of *Gastroblasta*. The adult Medusa is the result of continued budding, cotemporaneous with continuous but incomplete divisions, just as in the animal colonies of certain stone-corals. Many points in the new form call to mind *Porpita* or *Velella* among the Siphonophora; and it is to be remembered that Prof. Häckel ascribes a different phyletic origin from the other Siphonophores to the two genera just named. *Gastroblasta timida* from the Red Sea, described by Keller in 1883, has many points of resemblance to the new species.

New Sessile Medusa.*—Prof. C. Vogt discovered off the coast of Sardinia, at a depth of 50 fathoms, a small organism attached to the stem of a *Gorgonia*. This he finds to be a medusa, to which he gives the name *Lipkea Ruspoliana*.

It has the form of a flat soup-tureen; the umbrella is drawn out into eight short arms, into which the archenteron is continued; the convex surface of the umbrella is scooped out so as to form a sort of sucker, by which the Medusa remains fixed. The mouth is situated on a short four-sided manubrium, and leads into the archenteron, which is divided by four septa into as many stomachal pouches. There is no marginal canal. There are four pits in the subumbrellar surface, resembling the subgenital pits of the Acraspedota, but no genital organs were found; bundles of gastric filaments are present. The jelly is firm, as in the Craspedota, and only a few fibres (? muscular) are present near the sucker; but there is a circular band of muscular fibres round the margin of the umbrella. On the subumbrellar surface are numerous glands, containing rounded bodies, like young nematocysts. True nematocysts are present only on the convex surface; no marginal sense-organs were found.

Lipkea is, then, a new type of Häckel's Stauromedusæ, differing in certain points both from the Lucernaridæ and from Tesseridæ. Vogt defines the family as "Stauromedusæ with eight hollow arms; the bell fixed by a sucker; a continuous circular muscle; no tentacles, but exhibiting a considerable development of mucous glands." The author considers this new form as supporting his theory that the Medusæ are derived from forms primitively free-swimming, but in the development of which are intercalated degenerate, sessile, hydriform persons.

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 356–62.

Porifera.

Vosmaer's Porifera.* — The volume on sponges, by Dr. G. C. J. Vosmaer, in Bronn's 'Klassen und Ordnungen,' has just been completed in sixteen parts. The author is to be congratulated on the result of his labours. The defects, in regard to which he asks charitable criticism in his almost too apologetic preface, seem rather due to the nature of the subject and limit of space than to the author. The last five parts complete the systematic portion, and discuss in a perhaps slightly too compressed manner the ontogeny, physiology, distribution, and relationships of the group. Herr Vosmaer may be assured of the gratitude of every non-specialist who has attempted the identification of sponge forms.

Spongilla glomerata.†—Herr F. C. Noll describes a new species of fresh-water sponge from the island of Rügen, which differs in some important points from forms hitherto described. The gemmules were extraordinarily large, and are called gemmulæ balls by the author; they may be spherical, egg-shaped, or irregular in form, and are really masses of gemmules, six to fifteen being inclosed in a common investment. They give rise to the idea of a further division having gone on after the formation of extraordinarily large rudiments. On the surface of the balls there are a number of infundibular orifices, each of which is the pore of a gemmule, and all of which are so closely attached to the inner surface of the wall that when the ball is broken a gemmule remains attached to every piece of the investment.

The author describes the structure of the covering layer, and compares its constituents with those of allied species.

Herr F. Vejdovsky ‡ points out that this new species is nothing more than the widely distributed *S. fragilis* of Leidy, the synonymy and literary history of which are given in detail.

Fresh-water Sponges of Galicia.§—Herr A. Wierzejski has monographed the fresh-water sponges of Galicia, and considerably reduced the number of species. Within the genus *Spongilla* he recognizes only five subgenera, with five species. The multitudinous synonyms are carefully noted, and the following nomenclature proposed—(1) *Euspongilla lacustris* Vejd. (*Spongilla* auct.), (2) *Spongilla fragilis* (Leidy), (3) *Ephydatia fluviatilis* Vejd., (4) *Meyenia Mülleri* Wierz., (5) *Trochospongilla erinaceus* Vejd.

South Australian Sponges.‖—Mr. H. J. Carter continues and concludes his supplementary notes on the sponges collected in South Australia by Mr. J. B. Wilson; the four orders, Psammonemata, Rhaphidonemata, Echinonemata, and Holorhaphidota, being here dealt with. It is stated that the specimens have been deposited in the British Museum.

Protozoa.

Adoral Ciliated Organ of Infusoria.¶—The adoral ciliated organ of heterotrichous and hypotrichous Infusoria has been variously interpreted, by Stein as large cilia in grooves, by Sterki, Maupas, and Entz as skin plates. Prof. K. Möbius shows that the organ in question consists of

* Bronn's 'Klassen u. Ordnungen des Thier-Reichs, ii. Porifera,' 1887, Nos. 12–16, pp. i.–xii., 369–496, pls. xxvi.–xxxiv.

† Zool. Anzeig., ix. (1886) pp. 682–4. ‡ Tom. cit., pp. 713–5.

§ Ann. Acad. Sci. Cracovie, 1885. Cf. Arch. Slav. de Biol., ii. (1886) pp. 37–40.

‖ Ann. and Mag. Nat. Hist., xviii. (1886) pp. 369–79; 445–66 (1 pl.).

¶ Biol. Centralbl., vi. (1886) pp. 539–40 (Ber. 58 Versamml. Deutsch. Naturf. u. Aertze, Berlin, 1886).

ciliated combs or pectinellæ, which are composed of numerous fine cilia, whose connected basal portions form the transverse ridges of the ciliated organ. Prof. Möbius also describes the multiplication of *Freia ampulla* Müll. by unequal longitudinal division.

Contractile Vacuoles of Infusoria.*—Herr S. Fischer has investigated the contractile vacuoles of *Aspidisca lynceus* and *Paramæcium aurelia*. The former infusorian had three pulsating vacuoles; the largest to the right of the mouth with regular pulsations; the second of smaller size and posterior position, with pulsations alternating with those of the former; while the third and smallest exhibited irregular and less frequent pulsations. At the maximum diastole of the largest a thin drop appears close beside it, which increases gradually during the systole, and becomes the new vacuole. In *Paramæcium* the vacuole at its maximum extension is surrounded by a system of delicate canals, slightly swollen at a certain distance from the vacuole. During the systole the swollen extremities gradually come into contact to form a new vacuole. There is thus no definite membrane round the vacuoles. The contents were seen in *Aspidisca* to be expelled to the exterior. The pulsations are accelerated in deficient aeration of the water.

Bursaria truncatella.†—Herr A. Schuberg has studied *Bursaria truncatella* with special reference to protoplasmic structures. For the purposes of fixation he made use of the vapour of osmic acid, or, in preference, of Flemming's mixture of chromic, osmic, and acetic acid, especially as modified by Fol. After washing in water, and being placed in 1 per cent. osmic acid till they were slightly browned, the infusorians were ready for clearing up and preservation in Canada balsam. Sections were made after the object had been completely blackened by osmic acid, and further stained by strong Böhmer's hæmatoxylin.

The author commences by pointing out differences from the usually received accounts; he was not able to detect a complete symmetry, the greatest thickness of the hinder end of the body being somewhat towards the left side; the anterior end is always oblique. There appears to be some variability in the peristome; this portion arises from a straight peristome which lies quite free on the surface, undergoes a gradual insinking and a correlated spiral inrolling of the adoral zone; with this there may be connected that development of a septum which is due to the greater growth of some parts. Directly connected with the peristomial cavity is a space, the true relations of which seem to have escaped all previous observers. Though the form of the peristome varies considerably, it is always deepest on the right side of the animal, and its dorsal wall is hollowed out on the ventral aspect; towards the base of this cavity a septum becomes developed, and separates off a septal space; this septum is the only part of the peristome that carries cilia.

The origin of this arrangement is explained thus: As, cotemporaneously with the peristomial cavity, the hinder edge of the peristome grows forward in such a way that a flattened bridge extends from the left peristomial margin over the right margin, a cavity must be formed which is connected with the peristomial cavity at its hinder end, as well as along its left side. The boundary of this septal space on the side of the peristomial cavity, which are now only connected by a relative narrow cleft, is naturally formed by the primitively right peristomial margin, beset with cilia. Since the growth of the hinder peristomial margin did not take place along the right margin, but in a line somewhat more to the right, the

* Arch. Slav. de Biol., ii. (1886) pp. 288–9, from Wszechswiat, 1885.
† Morphol. Jahrb., xii. (1886) pp. 307–65 (2 pls.).

primitively free right edge came to lie in a cavity which it divides into two. The septum, therefore, which separates the peristomial cavity from the septal space is nothing more than the hindermost part of the primitively right peristomial margin, which by a special process of growth has become inclosed in the interior of the body. This history explains the presence of cilia on it.

With regard to the finer structural relations of this cell, the author compares the endoplasm to that of *Noctiluca miliaris*, for in both the large protoplasmic strands exhibit a fine plexiform structure. The ectoplasm is not of the ordinary type, but the outer layer is specially differentiated, and ought to be distinguished from what is seen in Rhizopods and many Infusoria. Attention is directed to its radiate structure, and it is shown that this has nothing to do with the presence of cilia. It is observed that in all the striations of the peristome the separate bands are connected with one another by transverse bars of protoplasm, which appear to lie deep. In prepared specimens it is possible to see on either side of a peristomial band a series of fine dots; if the focus be altered we get an optic section of a membranella, which is not simple, but is composed of two more or less approximated lines; if the focus be again altered, the fibrillated margin of the membranella may be seen. The fine dots appear to be the sections of the fine bands, and these perhaps are to be regarded as the primitive elements of the membranellæ. Further observations are necessary to determine whether we may regard the membranellæ of *Bursaria* as being made up of two rows of cilia. The transverse bands seen in the peristome are the points of attachment of the membranellæ.

Morphologically, the peristomial and the connected transverse bands are nothing more than specially thickened parts of the ectoplasm, which appear to owe their origin to the connection with the system of striæ in the peristome; so far as the author knows, nothing like them has been found in any other infusorian, and their function still remains to be discovered.

Food Habit of Petalomonas.*—Dr. A. C. Stokes believes that the flagellum in *Petalomonas carinata* arises from the bottom of the deep oral aperture. The animal feeds on bacilli and spirilla; when in the neighbourhood of masses of these bacteria, it comes to rest; the flagellum, with the exception of the free end, is motionless. The bacteria, either by their own movement, or by that of the free-end of the flagellum, knock against the motionless portion, and glide down into the oral aperture. From this they may escape, unless they touch the slightly oblique posterior wall of the oral pit when they are engulfed in the protoplasm. The bacteria are frequently seen to return again and again to the pit after their escape.

The author asks "What is the special attraction that leads them to congregate in the pit, and why should the bacteria allow themselves to be thus engulfed?" The latter probably is due to the oblique plane at the bottom of the pit.

Gymnodinium polyphemus.†—The specific name is given to this flagellate protozoon by M. Pouchet, from the fact that it possesses an eye of considerable complexity.

The eye consists of a transparent, highly refracting lens, rounded at its free extremity, which is always directed forwards. The inner surface is imbedded in a hemispherical cap-like mass of pigment, which represents a choroid. In some of the forms this pigment is red, in others black. In young forms, even when still encysted or undergoing fission, this lens is

* Sci.-Gossip, 1886, pp. 273-4 (1 fig.). † Comptes Rendus, ciii. (1886) pp. 801-3.

formed at first of six to eight refringent globules, which fuse with one another to form the single lens of the full-grown individual. The choroid, also, results from a concentration of pigment-granules, which are at first scattered.

New Foraminifer.*—Prof. H. Blanc describes a new Foraminifer, dredged in the Lake of Geneva, from a depth of 120–200 metres. He names it provisionally *Gromia Brunneri*, but thinks that it will probably deserve to form a new type of this genus. It is of large size, from 0·3 mm. to 1·0 mm.; it varies from flask-shaped to globular, and has a single opening. The shell, slightly lemon-yellow in colour, is formed of fine particles, probably siliceous, glued together. The protoplasm contains a single nucleus and several vacuoles; it covers the shell and forms a network similar to that of other species of *Gromia*.

Colonial Radiolarians.†—The thirteenth volume of the Monographs of the Naples Zoological Station contains an account of the Sphærozoa or colonial Radiolarians by Dr. Karl Brandt. The monograph treats of these forms under the four heads (1) Morphology, (2) Biology, (3) Reproduction and Development, and (4) Systematic, and in its exhaustive historical survey and independent investigation, as well as in its wealth of illustration, well supports the character of the splendid series. From the nature of the group the number of new results is not of course very great.

I. *Morphology.*—After a general introduction and historical sketch of the progress of our knowledge of the Sphærozoa, Dr. Brandt proceeds to a morphological survey. (1) *The protoplasm.* The central protoplasm differs physically and chemically from the peripheral. The latter consists of pseudopodia and assimilative protoplasm darkened by superosmic acid. The central substance is not so darkened, and this is but an index to other differences. (*a*) *The central substance* is divisible into two masses; the inner surrounding the oil-globules, the nucleus-containing vacuoles in spore-formation, as also pigment granules and large crystals; the outer surrounding the nuclei. (*b*) *The cortical substance* often contains abundant granules while the central contains none, or *vice versâ*. It consists, as noted above, of assimilative and of pseudopodic protoplasm. (2) *The nuclei.* In the vegetative period the nuclei are homogeneous. Those of the isospores are doubly refractive, which probably expresses a very fine differentiation. Those of the anisospores and of the "extracapsular bodies" formed in the young vegetative colonies are further differentiated. The phenomena of nuclear division in the anisospores of Collosphæridæ appeared to be very simple. (3) *The central-capsule membrane* is regarded as homologous with the cell-wall. In some vegetative colonies it appeared to be absent, but even then the central and cortical protoplasms were not exactly continuous. Pore-canals were observed in *Collosphæra huxleyi*. The membrane cannot be detected during or after the escape of the swarm-spores. (4) *The oil-globules* appear early and remain till the close of the vegetative life. In very young colonies and in the swarm-spores they are represented only by fine granules. Only in one form is there more than one large globule in each individual. The author doubts the existence of an albuminoid basis, and regards the inclosed substance as fat. (5) *The crystals*, which are present only during the reproductive period, are distinguished into large forms, which do not pass into the spores, and small forms which do. They are never truly crystalline. The large forms are excretions, the small

* Arch. Sci. Phys. et Nat., xvi. (1886) pp. 362–6.

† Fauna u. Flora des Golfes v. Neapel, Monographie, xiii. (1885) viii. and 276 pp. and 8 pls.

consist of an organic substance and are reserve material. (6) *The pigment* also occurs in the reproducing forms, is never diffuse but always granular, varies from blue to reddish violet, and appears simultaneously with the crystals. They are excretory masses, formed during the spore-building, and are left behind. Their chemical reactions are noted in detail. (7) *The connecting jelly-like substance* is normally present and is of great importance in keeping the colony together. It increases throughout the vegetative period both in mass and consistence, and becomes sometimes almost cartilaginous. It disappears rapidly in confined specimens. After the appearance of the zoospores it also decreases, first slowly and then rapidly. Even in dead spirit specimens some physical properties, e. g. of swelling out again in water, remain. Morphologically this substance is an excretion of the protoplasm. Physiologically, it is essential to the connectedness, protection, hydrostatic and even nutritive functions of the colony. (8) *Vacuoles* are not present in very young colonies. As the jelly-like substance becomes separated from the penetrating fluid, vacuoles are formed, to disappear again as spore-formation begins. They are surrounded by a fine plasmic layer. The variations in form and distribution are noted. The author regards them as entirely comparable to the vacuoles of other Protozoa. (9) *The skeleton.* The presence or absence of a skeleton cannot be regarded as establishing a natural division. In noting the mode of growth Brandt maintains the existence of an organic basis with subsequent silicification. He deprecates the erection of species on the variations of the spicules. (10) *Yellow cells.* These symbions, which Brandt has named *Zooxanthellæ*, are regarded as perhaps allied to the Peridineæ. The results of assimilation are starch-grains and also granules of different composition. Their presence at different periods, their behaviour when isolated, and other points are then noted. (11) *Individuality of colonies.* Colonies of different species cannot fuse, but colonies of the same species may, and that independent of the developmental stages of the two fusing forms. As Schneider has shown, artificial division is readily practicable. There is more division of labour within the colony than Hertwig allowed. The functions of intra- and extra-capsular protoplasm are quite distinct. The central capsule even, which solely forms the spores, is not homogeneous in its functions.

II. *Biology.*—(1) *Nutrition.* After noting general facts as to food material, Brandt emphasizes the truly nutritive function of the symbiotic algæ, which contribute the results of their assimilation (starch, &c.) to their animal host. The breaking up of these "yellow cells" during swarm-formation is specially noted, and also the changes in the assimilative protoplasm. (2) *Movement.* The plasmic portions being much heavier than sea-water are floated by the vacuoles and by the gallert-substance, which sometimes appear to be lighter than sea-water, and enormously increase the surface. Mechanical and thermal stimuli produce changes which effect sinking and rising. The pseudopodia affect the specific gravity through their influence on the vacuoles. (3) *Occurrence of different forms.* The distribution of ten species is described in detail, and graphically expressed in curves. The principal result shows their varied occurrence at different seasons. (4) *Environment.* (*a*) The Sphærozoa are very sensitive to changes of salinity. (*b*) They are uninfluenced by light. Even extreme illumination does not affect their vertical distribution. The statement of Geddes that Radiolarians move from the light is denied. (*c*) Apart from seasonal changes, alterations of temperature do not appear to have much effect upon these forms. On gradual cooling several forms were observed to sink. Two forms withstood a prolonged cooling to 1°, but exhibited changes

which after 2–3 days led to a reascent. (*d*) Movements in the water due to wind caused the Sphærozoa to sink. The direction of the wind, e. g the sirocco, had a marked influence which is discussed in detail. Certain currents also influenced the distribution to a noteworthy extent. (*e*) Dr. Brandt's observations are on the whole against any periodicity in the development of the Sphærozoa. (5) *The geographical distribution*, the derivation of these forms from the Atlantic, their absence in colder seas, &c., are then discussed. (6) *Phosphorescence.* The Sphærozoa are phosphorescent, but not with great intensity. The central portion alone is illuminated. The oil-globules are regarded as the seat of the process. (7) *Parasites and "Inquilinen."* Colonies of *Myxosphæra cærulea* frequently contained a parasitic amphipod, *Hyperia*, also Copepods, and Appendiculariæ; living diatoms also occurred in young Collozoa.

III. *Development and Reproduction.*—(1) *Division of the colony* seems certainly to occur, but Brandt was not able to observe the mode of formation of Collozoum chains supposed to occur by Häckel and Hertwig. (2) *Division of the individuals* was observed only in young vegetative colonies, and not in the older or in reproductive forms. (3) *Swarm-spore formation.* (*a*) *Isospores.* Hertwig's observations are generally corroborated, the main difference consisting in Brandt's denial of the statement that the whole mother organism is resolved into the spores. The greater part of the cortical substance is left behind and breaks up. The isospores of all Sphærozoa are said to have two flagella. (*b*) *The formation of an isospore* is distinguished from the above by the occurrence of groups of nuclei in the individuals, by the differentiation of the nuclei, and by the distinct macrospore and microspore nuclei. The anisospores differ further in their more or less bean-like shape, in their difference of size, in the character of their nuclei, and in the absence or peculiarity of crystals. The anisospores have much less reserve material than the isospores. The extracapsular changes are essentially similar. The cortical substance again breaks up, the yellow cells persist as before. (*c*) *Alternation of generations.* According to Brandt all the Sphærozoa have the above two modes of reproduction. In seven out of ten species the twofold method has been demonstrated. The Sphærozoa exhibit an alternation of generations as in algæ and fungi. He believes that from the union of the sexually dimorphic anisospores, a fused mass will result which will produce isospores. He has not, however, observed the conjugation of the anisospores. (4) *Extracapsular bodies* only occur in young colonies, which contain a few individuals. They always exhibit a more or less striking resemblance to the incipient stages in the intracapsular formation of anisospores. They arise by budding from the individuals, are refractive and without granules, but often with an oil-globule, usually with a fatty-mass, and always with a nucleus. True extracapsular bodies have not been observed in Collosphæridæ, but in young forms a somewhat similar phenomenon occurs. In some cases these budded bodies are normally modified into anisospores. In other cases they simply become individuals. In Collosphærids this reproduction within the young forms always results in rapid multiplication of the individuals; in Sphærozoa, anisospores sometimes are formed, though it is quite likely that in the latter also the extracapsular bodies may often form individuals. (5) *Development.* Five phases in the life-history are distinguished:—(i.) the swarm-spore, (ii.) the young vegetative phase, (iii.) the young reproductive phase with formation of extracapsular bodies, (iv.) the older vegetative phase, (v.) the older reproductive phase with formation of isospores and anisospores. In the vegetative phases the nuclei are homogeneous and simply refractive; in the reproductive they are dis-

tinctly differentiated or doubly refractive. The different phases are discussed at length, but the problems of length, transition, and conditions are still unsolved. Some notes on the reproductive phenomena in Acanthometridæ are then added.

IV. *Systematic.*—The Sphærozoida are distinguished from the Collosphærida chiefly in these points: in the formation of anisospores in S. the grouped arrangement of the nuclei persists till the spores begin to be formed, while in C. it is of a very short duration; in S. the macro- and micro-spores are formed in the same individual, in C., however, in different individuals; in S. true extracapsular bodies are formed, but these have never been observed in C.; on account of these developmental differences, therefore, the two families are distinguished. Since it is impossible to summarize the systematic portion of the work, it must suffice to note the net result.

SPHÆROZOA.

Fam. I. Sphærozoida.

Collozoum Hkl. Usually without skeleton, occasionally with isolated spicules.

1. *C. inerme* Müll sp.
2. „ *fulvum* n. sp.
3. „ *pelagicum* Hkl.
4. „ *Hertwigii* n. sp.

Sphærozoum Meyen. With siliceous spicules.

5. *Sph. punctatum* Huxl. sp.
6. „ *neapolitanum* Brandt.
7. „ *acuferum* Müll.
8. „ *Hæckeli* n. sp.
9. „ *spinulosum* Müll.

Fam II. Collosphærida.

Myxosphæra n. g. Without skeleton.

10. *Myxosph. cærulea* Hkl. sp.

Collosphæra Müll. With smooth latticed shell.

11. *Collosph. Huxleyi* Müll.

Acrosphæra Hkl. Latticed shell with pointed spines.

12. *Acrosph. spinosa* Hkl.

Siphonosphæra Müll. Latticed shell, in which the principal apertures are drawn out into tubes.

13. *Siphonosph. tubulosa* Müll.
14. „ *tenera* n. sp.

New Opalina.*—Under the name of *Opalina spiculata* Herr N. Warpachowsky describes a new species of *Opalina* which is found abundantly in the cœlom of young earthworms, and is characterized by the presence of a long spicule which lies in the body, and is about two-thirds of its length. It seems to be most closely allied to *O. prolifera* and *O. uncinata.*

Parasites in the Blood of Lizards.†—Prof. B. Danilewsky communicates a further report of his continued studies on blood-parasites. Along with M. A. Chalachnikow he has investigated those of lizards.

Within red blood-corpuscles which exhibited external peculiarities intracellular parasites or *Hæmocytozoa* were found, as in previous cases. Of intracellular forms three types are distinguished—(*a*) a large, quiescent

* Bull. Acad. Imp. Sci. St. Pétersbourg, xxx. (1886) pp. 512–4.
† Arch. Slav. de Biol., i. (1886) pp. 364–96 (2 pls.).

form, very like *Hæmogregarina stepanowi* of the tortoise, (*b*) a smaller, mobile form, and (*c*) a club-shaped form with slight mobility. Two forms were found much less frequently, and these seemed to be phases of (*b*, *c*).

All these cellular parasites are minutely described as regards structure, motion, effects, &c. The results of different reagents are also noted in detail. The simultaneous occurrence of different forms in the same individual, and the existence of several transition forms suggest a close relationship between the different forms. Further, there is a close affinity between the *Hæmatozoa lacertæ* and such Gregarinida as *Hæmogregarina testudinis*. As to the history of the parasites, Danilewsky is not yet able to supply definite information. His results have certainly shown the extensive distribution of such Gregarine forms, and are further of interest, as he notes, in affording favourable opportunity for studying the modifications of cellular life in response to peculiar environmental conditions.

Parasitic Protozoa in Ciona intestinalis.*—The first part of the results of Prof. C. Parona's study of the parasites found in the intestine of this Ascidian deals only with *Urospora Cionæ*. The author does not deal with the organisms to be found on and within the branchial region, or within the cloaca, nor with those numerous forms which settle upon the test of Ascidians, but only with those which are found amongst the contents of the intestine and stomach. These are studied by withdrawing the contents by means of a pipette, and taking every precaution to obtain the contents unmixed with any water from the exterior of the Tunicate. The structure of the Gregarine, which belongs to Schneider's genus *Urospora*, characterized by a set of caudal appendages, and is probably identical with Frenzel's form *Gregarina Cionæ*, is given, together with certain observations on its development.

The best method of preservation the author finds to be osmic acid 1 per cent.; the object is then mounted in glycerin, which drives out the osmic acid. The individuals are well preserved even at the end of three months.

BOTANY.

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

a. Anatomy.†

(1) Cell-structure and Protoplasm.

Destruction of the Molecular Structure of Protoplasm.‡—Herr W. Detmer has experimented on the mode in which injurious external agencies cause the death of the cell. For this purpose he found convenient objects in succulent acid organs, such as the leaf and leaf-stalk of *Begonia manicata*.

Chloroform kills the organ completely in about one hour. Coal-gas is much more rapidly destructive than hydrogen, the leaves becoming completely discoloured in the former gas in seven, in the latter in forty-eight hours. Dilute hydrochloric acid or potash causes flaccidity in a very short

* Journ. de Microgr., x. (1886) pp. 496-501 (1 pl.).

† This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‡ Bot. Ztg., xliv. (1886) pp. 513-24.

time. Exposed to an electrical induction-current, the leaves became somewhat flaccid after fifteen minutes, a brown colour began to show itself in three hours, and in twenty-four hours the destruction was complete. Injection of the intercellular spaces with water hastens the destruction of the tissues. A temperature of 40° C. for a short time appears to have no injurious effect; one of 55° causes death in about two minutes, one of 75° almost instantaneously. The action of various low temperatures is also described in detail.

In all these various cases the author determined that the cause of the death of the tissue was the destruction of the molecular structure of the parietal layer of protoplasm, by which it becomes permeable for the acid cell-contents. These pass out of the cells, partly into the intercellular spaces, and the cells thus lose their turgidity.

Structure of the Cell-wall.*—Herr G. Klebs criticizes Wiesner's recent theory † of the structure of the vegetable cell-wall. He notes especially (1) the absence of any proof that the dermatosomata are organized unit elements and not simply debris particles, and (2) the exceedingly unsatisfactory evidence as to the presence of protoplasm in the cell-wall. He denies the possibility of demonstrating Wiesner's distinction between (*a*) young living cell-walls in which the majority of the dermatosomata consist of living albumen, with numerous plasma strands between, and (*b*) an older dead stage in which the dermatosomata consist of cellulose, and have between them a connective mass also of cellulose. Further, he does not consider Raspail's reaction for albumen as altogether trustworthy.

Multinucleated Cells.‡—In a number of plants examined (*Polygonum Sieboldii*, *Acanthus mollis*, *Podophyllum peltatum*, *Eschscholtzia californica*, *Impatiens noli-me-tangere*, *Dictamnus Fraxinella*, *Linum pyrenaicum*, *Polygonatum multiflorum*) Mr. A. E. Grant found, on making longitudinal sections of the stem and petioles, that the cells of the wood-fibres contained several nuclei, sometimes amounting to as many as ten. These nuclei appeared in general to spring from the division of a single nucleus.

(2) Other Cell-contents.

Chemical Composition of Chlorophyll. §—Herr J. Wollheim gives a preliminary report of his recent researches on the chemical composition of chlorophyll.

Hansen's pure chlorophyll is shown to be impure alkaline chlorophyll. That prepared by Tschirch's method is also unsatisfactory. Herr Wollheim has endeavoured rather to form a pure derivative; but by means of alcoholic ammonia he was also able to obtain a solution of chlorophyll giving a pure spectrum. He points out the objections to the view that Hoppe-Seyler's chlorophyllan and Tschirch's barium-compound are pure substances. He has shown *inter alia* that iron is not an essential component of bodies in the chlorophyll group. His own treatment resulted in obtaining pure phyllocyanin acid, without iron, and free from all ash. He proposes the empirical formula $C_{28}H_{47}N_3O_6$. The spectrum of pure phyllocyanin acid appears to be identical with that of chlorophyllan, and a hydrochloric solution of pure phyllocyanin exhibits a spectrum identical with the alcoholic solution (1) of the author's zinc phyllocyanin (B-chlorophyll of Tschirch) and (2) of

* Biol. Centralbl., vi. (1886) pp. 449–55. † See this Journal, 1886, p. 818.
‡ Trans. Bot. Soc. Edinburgh, xvi. (1885) p. 38.
§ Biol. Centralbl., vi. (1886) pp. 541–2 (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886).

zinc chlorophyllan, and further with that of the leaf, apart from the displacement towards red exhibited in the latter.

Crystalloids in Pithecoctenium clematideum.*—Sig. R. Pirotta has investigated the distribution and nature of the crystalloids in the above-mentioned plant. As to *distribution* (*a*) in the root, they are much more abundant in the adult than in the young form. In the parenchyma of the deep layer of the cortex they occur abundantly, filling up the cells. They are also numerous in the cambium cells, but are absent from the outer woody portion and from the pith. (*b*) They are less frequent in the stem, especially in the young branches and in the pith. (*c*) In the leaves the crystalloids occur abundantly in the cortical parenchyma, but there is no trace of them in the hairs. They are more abundant in the spongy than in the palisade parenchyma, and accompany the bundles in considerable numbers in the parenchyma and soft bast. (*d*) In the tendrils they occur in scattered groups, especially in the cortical parenchyma and in that which accompanies the bundles. (*e*) In the inflorescence there are not a few in the flower-stalk, and especially just at the base of the flower. (*f*) They occur more or less abundantly in all the floral organs, and abundantly in the fruit, decreasing with ripeness. They do not occur in the seed.

These sphærocrystals vary considerably in size and colour. Numerous fine crystalline acicular prisms radiate out from a centre, which corresponds to a kind of solid amorphous nucleus within the cell. The crystalloids form very simple bundles, or compact hemispherical or spherical bodies. They are soluble in the living cell-sap, in boiling alcohol, glycerin, acetic acid, ether, &c, and their various reactions are noted.

The author believes with Hansen that the substance composing the crystalloids is originally dissolved in the sap, from which it is separated in drops, becoming subsequently crystalline. A list of various sphærocrystals is then given, showing their wide and varied occurrence.

(3) Secretions.

Formation of Oxalic Acid in Vegetation.†—MM. M. Berthelot and E. André have selected and examined at various stages of their growth the following plants:—*Rumex acetosa*, *Amaranthus caudatus*, *Chenopodium quinoa*, and *Mesembryanthemum crystallinum*. The juice of the first is always acid, that of the second and third neutral or feebly acid, whilst that of the last is neutral in the early stages of growth, but becomes acid as the plant developes. The plants also differ very considerably in the ratio between the soluble and insoluble oxalates which they contain.

Rumex acetosa.—The seed or dried fruit contains 0·05 per cent. of oxalic acid. In the early stage of growth (June 8th) the root contains 13·9 per cent. of oxalic acid 5·1 per cent. being soluble and the remainder insoluble. The proportion of ash is 20·7 per cent., and some of the acid is in the free state. When the plant is in active vegetation (June 26th) the proportion is about 10 per cent., and it is especially abundant in the leaves and branches, and least abundant in the root. The oxalates may exist in the form of double salts of potassium, calcium, and magnesium, or in that of ethereal salts which are ultimately decomposed in contact with calcium compounds. When the plant begins to fructify (September 27th) the absolute amount of oxalic acid has increased, but in much lower proportion than the increase of the whole plant; the percentage amounts to one-

* Rev. Ital. Sci. Nat., ii. (1886) pp. 61–3, from Ann. Ist. Bot. Roma, ii. (1886).

† Comptes Rendus, cii. (1886) pp. 995–1001, 1043–9. Cf. this Journal, vi. (1886) p. 90.

fourth of what it was at the early stage of growth. The leaves of *R. acetosa* are very rich in nitrogenous substances, and are the principal seat of the formation of oxalic acid and of the destruction of the nitrates.

Amaranthus caudatus contains a considerable proportion of nitrates, and the oxalic acid is mainly in an insoluble form. At the commencement of flowering (June 18th) the percentage of oxalic acid was 5·86.

Chenopodium quinoa yields a neutral juice which is almost free from nitrates, but contains a relatively large proportion of soluble oxalates. In the early stage of growth (May 18th) the percentage of oxalic acid was 3·9, and the bases in the ash (25·6 per cent.) were far more than sufficient to neutralize the whole of the acid.

Mesembryanthemum crystallinum.—The seed does not contain oxalic acid. In the early stage of growth (June 9th) a considerable quantity of oxalic acid is formed, a part being in the soluble form. As growth proceeds the juice becomes acid, and at a later stage, when the flowers begin to open, it becomes neutral in the root, but is acid in the stalks and leaves.

(4) Structure of Tissues.

Assimilating System.*—Dr. G. Haberlandt contests the theory of Stahl that the factor which exercises the greatest influence on the structure of the assimilating system of plants, and especially on the palisade-parenchyma of leaves, is the intensity of light. His view is rather that it is governed chiefly by the facility which it affords for the conduction of the food-materials. Although in the great majority of cases the statement of Stahl is correct, that in the palisade-cells the chlorophyll-grains take up their epistrophic or apostrophic position according to the direction and intensity of the light, yet it can be shown, especially in those instances where the walls of these cells are curved or oblique, that the determining influence is the anatomical structure of the walls themselves. Those cell-walls through which the current of food-material passes, or a regular metastasis takes place, are free of chlorophyll-grains.

The theory that the oblique position of palisade-cells is a direct contrivance for the transmission of light, is contradicted by the fact that it occurs in conditions where light is entirely excluded, as in leaves inclosed within buds or even buried in the ground. Evergreen leaves, even when growing in the shade, contain an abundant palisade-parenchyma. The author regards the influence of light on the greater or less development of the assimilating system as simply an example of irritation which has become hereditary; and where this inherited tendency to a copious development of the assimilating tissue is wanting, even the most intense illumination is powerless to produce it.

The principles of the structure of the assimilating tissue, on the above theory, are explained in detail; and it is pointed out that the arrangement best adapted for the assimilating cells to carry out their function is when they are placed radially round the vascular bundles.

Vascular Bundles of Zea Mays.†—Herr H. Potonié describes the development of the small anastomoses which, in the leaves of the maize, connect the principal longitudinal vascular bundles transversely with one another, and points out the singular fact that the conducting tissue represented by the parenchyma-sheath of these anastomoses is of the same origin as the elements of the anastomosing bundles themselves, and differs in origin from the parenchyma-sheaths of the principal bundles, which are of a similar value from a physiological point of view.

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 206–36 (1 pl.). † Ibid., pp. 110–2 (1 fig.).

Interruption in the Pith of Coniferæ.*—Herr C. Fritsch has determined that this phenomenon is due, not to external causes, but to changes in special groups of cells, ending in their complete disappearance. The cavities formed in this way are never filled with turpentine or resin. The phenomenon is confined to the genera *Picea*, *Abies*, *Larix*, and *Cedrus*, and is not found in all species of these genera.

Ant-entertaining Plants.†—In addition to the plants enumerated by Beccari ‡ as being inhabited by ants, Herr H. Karsten describes another, *Cecropia peltata*, in which the ants inhabit peculiar cavities in the internodes formed by a peculiarity in the growth of the plant. In those specimens in which ants have taken up their abode, these cavities are connected with one another by circular perforations, while in those which are not so inhabited, the cavities remain distinct.

Laticiferous Vessels.§—Sigg. Pirotta and Marcatili have studied the distribution and relations of the laticiferous system in a number of orders, with the general result of corroborating the suggestions of Haberlandt. ‖ (1) In *Apocynaceæ* the laticiferous vessels are distributed in a twofold manner within the leaf. (*a*) The vessels follow the veins to their last ramifications, forming a fine net in the parenchyma, and coming into more or less direct connection with the assimilating cells. (*b*) After accompanying the bundles so far, the laticiferous vessels leave them, penetrate freely into the parenchyma of the mesophyll, and become applied to the assimilating cells. (2) In *Asclepiadaceæ* (*a*) with reduced or modified leaves, the very numerous laticiferous vessels run in all directions through the assimilating subepidermal parenchyma of stem and branches, exhibiting close connection with the assimilating cells. (*b*) In those with normal leaves the connections between assimilating cells and the laticiferous vessels are much more manifest. They follow the veins and then part from them, traversing the parenchyma and frequently penetrating between the palisade-cells. (3) In *Euphorbiaceæ* (*a*) with reduced modified leaves the laticiferous vessels are cortical or medullary, but always in close connection with the assimilating cells. (*b*) In those with normal leaves the laticiferous vessels follow the vascular bundles for some distance, and then leave them, becoming isolated and exhibiting intimate connections with the green cells. (4) In *Campanulaceæ* and (5) *Lobeliaceæ* the vessels either accompany the bundles to their fine terminations, or traverse the parenchyma, often ending in the spongy tissue, surrounded by a considerable number of conducting cells. (6) In *Papaveraceæ* the laticiferous vessels follow the bundles and end with them, or else traverse the spongy tissue, and, passing between the palisade cells, end finally below the epidermis. (7) In *Araceæ* the laticiferous vessels frequently ramify in the parenchyma, or pass between the palisade cells to the epidermis. (8) In *Musa* the laticiferous vessels never leave the bundles, but become associated with the palisade cells.

(5) Structure of Organs.

Origin and Development of the Lateral Roots in Dicotyledons.¶—According to M. A. Lemaire, the immense majority of the lateral roots of

* Schrift. K. Phys.-Oek. Gesell. Königsberg, xxv. (1885). See Bot. Centralbl., xxvii. (1886) p. 218.

† Flora, lxix. (1886) pp. 304–6.

‡ See this Journal, v. (1885) p. 484.

§ Rev. Ital. Sci. Nat., ii. (1886) pp. 60–1, from Ann. Ist. Bot. Roma, ii. (1886).

‖ See this Journal, 1883, p. 868.

¶ Ann. Sci. Nat. (Bot.), iii. (1886) pp. 163–272 (6 pls.).

Exogens are of endogenous origin, from the deeper tissues of the stem; the Cruciferæ furnish an exception, the lateral roots being exogenous in that order. It is most frequently the case in Dicotyledons that the lateral roots are formed at the expense of a layer of cells at the periphery of the central cylinder of the stem itself formed from the pericycle. The roots are sometimes formed at the portion of the pericycle which faces the vascular bundles, sometimes at the side of the bundles, while sometimes they spring from the intervals between the bundles. When the pericycle is simple, it first divides into two layers by tangential walls; the lower layer gives birth to the central cylinder of the root; the superficial layer again divides into two, the inner layer producing the cortex, the outer the root-cap and the piliferous layer. When the pericycle is composed of several layers, the cells of the internal layer form the central cylinder of the root, while the cortex, the piliferous layer, and the root-cap spring from the outer layer.

The endoderm or the last layers of the cortex in some cases take their share in the development of the root. It gives place to a tissue (the *calotte*), composed of one or more layers which clothe the root-cap. Sometimes the cells of the endoderm, full of protoplasm, divide in the radial direction, and produce a layer of cells extending to the surface of the root-cap; or the endoderm first developes round the young root a layer which subsequently divides into two by tangential walls; or several inner layers of cortex are associated in producing several layers of "calotte." In some plants the cortex of the root is altogether inactive.

In plants belonging to the Leguminosæ the pericycle of the stem gives birth only to the central cylinder of the root, while the other parts are derived from the last layers of the cortex of the root. In some cases again (*Vinca major*, *Viola palustris* and *odorata*) the roots are not formed at the expense of the pericycle, but from a meristem situated within the liber of the bundles of the stem, in other words, from the intrafascicular cambium. In *Asperula odorata* the central cylinder of the roots proceeds from a generating layer beneath the liber; the other parts are produced from the pericycle. In the Cruciferæ the lateral roots are exogenous; their central cylinder is the result of divisions in the second layer of the cortex of the stem; their cortex results from segmentations in the outermost layer of this same cortical tissue; the piliferous layer and root-cap have a common origin, viz. the epidermis of the stem.

Aerial Roots of Sonneratia.*—Herr K. Goebel has examined the roots of this tree, growing in tropical swamps, and has determined that they are not pathological structures, as previously supposed, but normal roots which emerge from the water or mud owing to their negative geotropism. He regards their function as being connected with respiration, to bring the roots in direct contact with the atmosphere in consequence of the small amount of oxygen contained in the mud.

Structure and Function of the Subterranean Parts of Lathræa squamaria.†—Mr. G. Massee describes in detail the structure of the scale-leaves and "haustoria" of this plant, which he regards as a saprophyte rather than a true parasite. The haustoria or discs, by means of which nutriment is obtained from the host, are about a line in length, are best developed on the primary rhizome and its branches, and may be terminal or interstitial; sometimes they are so numerous as to give a moniliform appearance to the rootlets; but are sometimes almost altogether absent

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 249–55.
† Journ. of Bot., xxiv. (1886) pp. 257–63 (1 pl.).

from old roots. The central vascular portion of the disc penetrates to the pericycle of the host, from which it absorbs nutriment, the penetration being effected by the secretion of some corrosive substance.

The large cavities in the scale-leaves contain glands of three kinds, viz. (1) Stipitate glands springing from a single epidermal cell; the pedicel usually one-celled, the head composed of four cells filled with dense granular protoplasm; this is the most common form. (2) Sessile glands with a broadly elliptical basal cell; the head composed of four long narrow cells containing granular protoplasm; this form is also abundant. (3) Glands with long slender jointed pedicel and small multicellular head, agreeing in structure with the glands that cover the rachis and bracts, but which are very rare in the cavities. The cavities of the leaves do not contain air, but water with an acid reaction, due to a secretion from the stipitate glands. The large sessile glands exercise an absorptive function, certain inorganic and organic matters from the humus being in all probability absorbed and assimilated by the plant.

Further details are given of the nature of the tissues of which the scale-leaves are composed, as shown by microchemical tests.

In some instances the roots are covered by the mycelium of a fungus; but this is not sufficiently constant to regard the phenomenon as one of symbiosis similar to that which occurs in *Monotropa*.

Rhizopod-like Digestive Organs in Carnivorous Plants.*—Herren A. Kerner v. Marilaun and R. Wettstein v. Westersheim describe the contrivances for the capture and digestion of insects in *Lathræa squamaria* and *Bartsia alpina*. On the back of the underground non-chlorophyllaceous leaves of *Lathræa* are cavities, the inner walls of which are clothed with glandular organs of two kinds, stalked capitate hairs and sessile 2–4-celled sterile elliptical organs, the latter in connection with the vascular-bundle system of the leaf. The outer membrane of both organs is provided with extremely regular perforations, from which, under certain circumstances, extremely fine protoplasmic threads project outwards. These threads come into contact with the products of decomposition of the animals (infusoria, mites, &c.) which perish in the cavities. No excretion of any special fluid could be detected. At the commencement of the period of vegetation, the absorption of nutriment in *Lathræa* takes place chiefly through the haustoria, and the quantity of the remains of animals found in the cavities is extremely small. Towards autumn the haustoria partially disappear, and the number of insects captured increases.

In *Bartsia alpina* similar organs are found in peculiar hollows formed by the leaves, the margins of which are recurved in vernation. The leaf-buds are underground, and the structure of the cavities is similar to that in *Lathræa*.

Forms of Leaves and Cotyledons.†—The presidential address of Sir John Lubbock to the Linnean Society is devoted to a discussion of the forms of the leaves and cotyledons of Flowering Plants in relation to their biological requirements. After a few remarks on leaves, especially in regard to their form and their venation, he proceeds to a discussion of seedlings. The variations in the cotyledons of dicotyledonous plants are described, especially in relation to their size and form, the likeness or unlikeness of the two cotyledons to one another, and the size of the embryo in comparison to that of the seed. Sir John Lubbock concludes that the conditions under which seedlings are grown naturally exert some influence

* SB. K. Akad. Wiss. Wien, xciii. (1886) (1 pl.). See Bot. Centralbl., xxvii. (1886) p. 289.

† Journ. Linn. Soc. Lond. (Bot.), xxxii. (1886) pp. 341–401 (134 figs.).

on the form of the leaves; and he finds an almost inexhaustible supply of beautiful adaptations to purpose in this respect; while, on the other hand, there are not wanting cases in which it would seem that the adaptation is not complete.

Leaves of Water-plants.*—M. J. Costantin publishes the results of a large number of observations on the peculiarities of the morphology and internal structure of the leaves of plants growing either normally or accidentally in water.

As a general law it may be stated that submersion modifies the development of leaves, tending to increase their surface at the expense of their thickness, whether in one plane or by numerous capillary subdivisions. If a plant growing in the air is submerged the undeveloped leaves will undergo changes in this direction, while the adult leaves will perish; in the former case the changes of medium may act directly or indirectly in bringing about adaptations in the leaves. The capillary division of the leaves of aquatic plants occurs exclusively with Dicotyledons (*Ranunculus*, *Myriophyllum*), while elongation in one direction is chiefly characteristic of Monocotyledons (*Sagittaria*, *Vallisneria*, &c.). Many aquatic plants have different forms of leaves, according as they are submerged, floating, or aërial (*Sagittaria*, *Alisma*, *Nuphar*).

As regards the structure of the epidermis, the immediate action of an aquatic medium is manifested in the complete or approximate disappearance of stomata from the submerged leaves and from the lower surface of floating leaves; and in the submerged leaves of plants normally aërial, by the diminution of their number on the upper as compared with the lower surface. In *Stratiotes* the exposed portion of the leaf possesses stomata, while the submerged portion of the same leaf is destitute of them. In a plant growing in shallow water, the stomata may be formed even in the bud on leaves which will subsequently expand on the surface or be completely exposed. Further changes are shown in the walls of the epidermal cells becoming rectilinear and diminishing in thickness, in the external wall (cuticle) not becoming suberized, in the disappearance of hairs, and in the appearance of chlorophyll in the epidermal cells. In the mesophyll the lacunæ show a tendency to increase in number, accompanied by a reduction of the fibrovascular and other strengthening elements. The palisade-tissue also disappears or becomes greatly reduced. These changes appear to be the direct result of the change of medium.

Growth of Hairs on Etiolated Organs.†—From the examination of a large number of plants artificially etiolated, Herr A. Schober concludes that etiolation does not itself affect the form or length of the hairs on the stem, leaves, or root; although the hairs are larger or smaller in proportion to the vigour of growth of the plant itself.

Cilia of Luzula.‡—According to Herr F. Buchenau the cilia on the leaves of all species of *Luzula* are expansions, not of the epidermis of either surface only, but of a layer of cells resulting from the union of the epidermis of both surfaces. They consist of three or four cells at the base, at the apex of a single apiculate cell. In the allied genus *Juncus* a similar structure was found only in *J. trifidus*.

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 94–162 (5 pls.). Cf. this Journal, 1885, p. 674.

† Zeitschr. f. Naturwiss., iv. (1886) pp. 556–78. See Bot. Centralbl., xxviii. (1886) p. 39.

‡ Abhandl. Naturwiss. Ver. Bremen, ix. (1886) pp. 293–9. See Bot. Centralbl., xxvii. (1886) p. 220.

Morphology of the Flower of Orchideæ.*—Prof. E. Pfitzer describes in great detail the structure of the flower of orchids, the result of observations on a very large number of species, chiefly exotic.

The inferior unilocular ovary he regards as a hollow flower-stalk, down the inner surface of which run the margins of the three carpels as seminiferous placentæ.

The spur varies greatly in morphological value. We have (1) spurs of purely axial character (*Epidendron*, *Lælia*, *Cattleya*, *Dendrobium*, &c.); (2) spurs which are half-axial (*Chænanthe*, *Comparettia*, *Phajus*, *Saccolabium*, *Anectochilus*); (3) of purely foliar nature (*Disperis*, *Huttonæa*, *Coryanthes*).

The labellum may be divided into three parts:—hypochilium, mesochilium, and epichilium. The labellum does not in all cases correspond to the median petal; one or more of the other petals or the axis may take part in its formation.

Prof. Pfitzer dissents from the ordinary conception of the column as a product of the adhesion of the upper part of the carpels with one or two fertile stamens, in addition sometimes to two or three staminodes. He regards the column, on the contrary, as purely axial in its character, similar to that of *Passiflora*, *Cleome*, and *Gynandropsis*. There are all stages of transition between orchids with no gynostemium, like *Diuris*, and those with a long and slender column; as also between those with true pollinodes and those with ordinary powdery pollen.

Development of the Flowers and Fruit of Typha and Sparganium.†—According to Dr. S. Dietz the development of the flowers in these two genera, while showing in many respects a general relationship, exhibits such material differences as to justify their being placed in different families. The seed of *Typha* contains a single layer of perisperm and an endosperm composed of several layers; the long embryo occupying a central position along the axis of the seed; the small-celled and thin-walled perisperm can only be made out by staining. The detection of the aleurone-grains and nucleus in the cells of the perisperm is also difficult without staining, but the author states that he was able to determine the invariable presence of the latter.

Pollen of Iris tuberosa.‡—Under the name of "Gasparrini's vesicular organ," Sig. G. Licopoli describes a peculiar vesicular structure which he finds in the pollen-grains of *Iris tuberosa*, and of some other monocotyledonous plants. It appears to be nothing but the vegetative cell of the pollen-grain or its nucleus.

Nectary of Erythronium.§—Dr. S. Calloni describes in detail the structure of the nectary of *Erythronium dens-canis*, which does not, however, present any striking peculiarities. Its position is designed to assist in the cross-fertilization of the flower, especially by Hymenoptera and Coleoptera.

Seeds of Aldrovanda.‖—Herr S. Korzchinsky describes the structure of the seeds of *Aldrovanda vesiculosa*. The integument consists of five layers:—an outermost black palisade-layer, a delicate spiny lamella, an inner brown palisade-layer, a delicate colourless layer, and the innermost

* Pfitzer, E., 'Morphologische Studien üb. d. Orchideenblüthe,' 139 pp. and 64 figs., Heidelberg, 1886.

† Bot. Centralbl., xxviii. (1886) pp. 26–30, 56–60.

‡ Atti R. Accad. Sci. Fis. Napoli, ii. (1885) (1 pl.). See Malpighia, i. (1886) p. 36.

§ Malpighia, i. (1886) pp. 14–9 (1 pl.).

‖ Bot. Centralbl., xxvii. (1886) pp. 302–4, 334–5 (1 pl.).

integument; these inclose the ovoid nucellus. The germination of the seeds was also followed out, presenting the peculiarity of the almost complete suppression of the radicle.

Latent Vitality of Seeds and Rhizomes.*—Dr. Fritz Müller writes from Brazil to Dr. F. Ludwig, noting some interesting cases in which seeds or rhizomes must have remained for a long time latent. In a felled wood a variety of *Ricinus*, seedlings of Mandioc, a conspicuous *Caladium*, a *Dioscorea*, &c., sprang up as the results of cultivation twelve years before, though before the ground was recleared there was no trace of them. In another case an individual *Gloriosa superba* was lost for eight years, during which it must have remained latent. The shades of the wood afford very uniform conditions which favour this retention of life without development.

β. Physiology.†

(1) Reproduction.

Fertilization of the Hollyhock and of Indigofera.‡—Contrary to the general opinion, and notwithstanding the size and beauty of the flower, Mr. T. Meehan maintains that the hollyhock is necessarily self-fertilized, and that this self-fertilization is assisted by insects. When insects seat themselves on the open anthers immediately after the opening of the flower, they force a quantity of pollen down into the staminal tube upon the immature stigmas. When the stigmas rise above the mass of anthers and are ready for pollination, they are so entirely covered by this pollen, that it is almost impossible for a grain of foreign pollen to reach them.

The structure of the flowers of *Indigofera Dosua* Mr. Meehan regards as specially favourable neither to self-fertilization nor to cross-fertilization; but the great probability is that in the majority of cases the flowers are self-fertilized.

Fertilization of Labiatæ and Borragineæ.§—Herr E. Loew describes in detail the adaptations to insect fertilization in the flowers of a number of species belonging to these two natural orders.

The Labiatæ are visited chiefly by humble-bees and other bees with a long proboscis; next in the frequency of their visits come butterflies and flies; and last, bees with a short proboscis, and insects belonging to other orders. By far the greater number of the species are proterandrous. Further contrivances for preventing self-pollination and for the scattering of the pollen are described. The cause of attraction of insects is the odour of a strongly aromatic essential oil. As regards the history of development of the flowers of the Labiatæ, the author suggests that the primary form is a short-tubed pentamerous corolla with a distinct tendency to zygomorphism, a nectariferous ring beneath the ovary, and a strong tendency to proterandry.

The Borragineæ agree with the Labiatæ in the classes of insects which take the chief part in their fertilization, bees with a short proboscis coming next, and butterflies and flies last of all, the number visited by butterflies being very small. The contrivances for pollination are by no means so numerous as in the Labiatæ; among them may be mentioned the peculiar nature of the inflorescence so constant in the order, and the

* Biol. Centralbl., vi. (1886) pp. 513–4.

† This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

‡ Proc. Acad. Nat. Sci. Philad., 1886, pp. 291–4.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 113–43, 152–78, 198–9 (3 pls.).

common occurrence of a change in the colour of the corolla. In *Arnebia echioides* he finds that the long-styled form exhibits only a slight decrease of fertility when impregnated with its own pollen.

Fertilization of Yucca.* — Mr. W. Trelease corrects Prof. Riley's observation with regard to the presence of a nectary in the stigma of the capsular Yuccas, no secretion taking place from the stigma except that of the stigmatic fluid. He confirms Riley's statement that the yucca-moth (*Tegeticula yuccasella*) deliberately goes to the stamen and accumulates a supply of pollen on its remarkable spinose tentacles before beginning the work of pollination and oviposition.

New Case of Parthenogenesis.†—Dr. A. Ernst describes a plant found by him in Caracas, and named *Disciphania Ernstii*, belonging to the Menispermaceæ, which appears to exhibit true parthenogenesis. Female plants which bore no male flowers, and which were grown perfectly isolated where there was no possibility of the access of pollen from another plant, produced in three successive years an increasing number of fertile fruits. Dr. Ernst was unable to determine whether the embryo was developed as an outgrowth from a cell of the nucellus, as in *Cœlebogyne*, or whether it was the development of an unfertilized oosphere; but he believed it to be the latter. The fertile flowers appeared to be developed on embryos with a thicker rachis than the barren ones.

(2) Germination.

Formation of Endosperm-Tissue.‡—According to observations made on a number of species of dicotyledonous plants by Herr F. Hegelmaier, the usual statement that the formation of the endosperm takes place in two different ways, either by free-cell-formation or by the division of the embryo-sac, must be accepted with some modification. The cases included under the former head are not referable to free-cell-formation in the strict sense of the term, but rather essentially to the division of a protoplasm-body. The term free-cell-formation can only be retained if it is applied to all those cases where the formation of fresh septa appears to be quite independent of the previous divisions of the nucleus.

In *Lonicera caprifolium* the protoplast of the broadly fusiform embryo-sac, which is surrounded only by the thick integument, forms before impregnation, as respects the greater part of it, a rather thin parietal layer; the nucleus being not in the centre, but in a peripheral position close to the egg-apparatus. As the embryo-sac increases in size, the nucleus divides by repeated bipartition. During the later stages of this bipartition, a number of small vacuoles are formed in the parietal layer, and the embryo-sac presents, on superficial view, the appearance of a net. The entire embryo-sac may now become suddenly filled with a cellular mass, and all intermediate stages occur between this and a simple parietal layer. The division-walls of the tissue thus formed show the same capacity for staining with carmine and iodine, and the same resistance to sulphuric acid as the protoplasm. The cell-cavities of this structure are unquestionably derived from the vacuoles in the protoplasmic layer, the division-walls from the separating bands of protoplasm. Differentiated septa of cellulose are formed at a subsequent period.

In *Viburnum* and *Sambucus* the embryo-sac is shorter and broader than in *Lonicera*. No vacuoles appear in the parietal layer of protoplasm; the

* Bull. Torrey Bot. Club, xiii. (1886) pp. 135–41 (3 figs.).
† Nature, xxxiv. (1886) pp. 549–52 (16 figs.).
‡ Bot. Ztg., xliv. (1886) pp. 529–39, 545–55, 561–78, 585–96 (1 pl.).

entire inner cavity of the embryo-sac presenting the appearance of being instantaneously broken up by thin lamellæ of protoplasm. In *Symphoricarpus* the variation in the same direction from the structure in *Lonicera* is still more strongly displayed, a powerful development of protoplasm taking place in the centre of the embryo-sac in the form of a mass of chambers, the dividing walls of which consist of protoplasm in which septa of cellulose subsequently make their appearance. The division of the embryo does not begin in the Caprifoliaceæ until after the complete formation of this endosperm.

Adoxa agrees essentially with *Sambucus* in the mode of development of the endosperm, differing altogether from that of *Chrysosplenium* with which some authors propose to associate it. *Hedera* shows affinity in this respect with the Caprifoliaceæ, especially *Viburnum* and *Sambucus*, rather than with the Umbelliferæ. The ovule is monochlamydeous and bilateral, but is distinguished from that of the two genera named by the presence of a small quantity of nucellar tissue at the time of flowering.

In *Galium* and *Asperula* no vacuoles are to be discovered in the parietal layer of protoplasm in the embryo-sac, nor any breaking up into chambers. The protoplasm subsequently breaks up into a number of polyhedral cells, some of which contain two or three nuclei, though finally the endosperm consists of uninucleated cells. The suspensor branches into a number of haustorium-like appendages which penetrate the endosperm.

In *Borrago* the author was unable to confirm the statement of Hofmeister of the formation of an endosperm-tissue at the chalaza-end of the embryo-sac. There is here a central band of protoplasm running in a longitudinal direction through the embryo-sac, which afterwards breaks up into a number of plates. *Heliotropium* had been described by Rosanoff as exhibiting free-cell-formation in the upper, cell-division in the lower part of the embryo-sac; Hegelmaier was unable to confirm this; finding, in the lower part as well as the upper, the formation of septa coincident with the division of the nucleus. Strictly speaking, in *Heliotropium* the embryo-sac itself does not divide in the formation of endosperm, but only its contents; and this is still more strikingly the case in *Specularia*.

In *Atropa* the endosperm is the result of true cell-division; as is also the case in *Asarum*. In the Labiatæ the embryo-sac is divided by an isthmus-like neck into two parts of unequal size, and the formation of endosperm takes place only in the smaller of these by cell-division.

The author next points out differences in the mode of development of the endosperm in *Nuphar* and *Nymphæa*, although belonging to the same type.

He concludes that no sharp line of demarcation can be drawn between different modes of development of the endosperm, whether you take as the distinguishing character the coincidence or otherwise of the formation of septa with the division of the nucleus (cell-division and free-cell-formation), or the fact that in some cases it is the embryo-sac itself that divides, in other cases only its protoplasmic contents.

(4) Growth.

Effect of Sunlight on Etiolated Seedlings.*—According to Dr. J. Reinke, when etiolated seedlings of cress were placed under a normal solar spectrum, the green colouring invariably took place most rapidly on both sides of the line C, about in the interval λ 635–λ 675; the curve falling

* SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 94.

from this maximum towards both ends of the visible spectrum. When the light was sufficiently strong, heliotropic curvatures took place even in the yellow.

Assumed Decomposition of Carbonic Acid by Chlorophyll.*—Reverting to this subject, Dr. N. Pringsheim repeats his previous arguments that we have no direct evidence that the colouring matter of chlorophyll is the agent which brings about the decomposition of the carbon dioxide of the atmosphere. So far from the blue and violet rays, which are the most eagerly absorbed by chlorophyll, being the most active in the decomposition of carbon dioxide, they are almost inoperative in diffused daylight. The author also lays stress on the fact that in artificial solutions of chlorophyll obtained from leaves there is no mutual reaction between the colouring matter and the carbon dioxide of the air; but that, on the contrary, when exposed to light, the chlorophyll loses its colour and gives off carbonic acid; and experiment proves that the same takes place in every living cell under the influence of light. While pure carbon dioxide produces no effect on the chlorophyll of the living cell, the least trace of oxygen bleaches and destroys it in the course of a few minutes, when exposed to a sufficiently intense illumination.

Decomposition of Carbonic Acid by Chlorophyll outside the plant.†—Dr. N. Pringsheim contests the accuracy of the observations of Regnard, according to which carbon dioxide was decomposed by a layer of chlorophyll placed on strips of cellulose.

He also comments on the statement of Timiriazeff, that a substance can be obtained from chlorophyll by reduction by means of hydrogen in a nascent condition, which has the same property of decomposing carbon dioxide; and points out that if this observer's last observations are correct they altogether contradict his previous statement ‡ with regard to the coincidence of the maximum of evolution of oxygen with the absorption-band in the red in the spectrum of chlorophyll, and confirms Pringsheim's own views on this subject. §

(6) Movement.

Theory of Twining.—In pursuance of the controversy on this subject, Prof. S. Schwendener‖ replies to the arguments of Wortmann, ¶ insisting on the importance of the clasping movement (Greifbewegung) as an element in the causes of twining, this movement not being by any means confined to the free apical portion of the stem. His observations were made almost exclusively on *Calystegia dahurica*. He contends that the phenomena of this and other twining plants cannot be accounted for by the operation of nutation and geotropism alone, the comparative rapidity of the movements and their permanent character being evidence of this. The free movement of the apex due to nutation and geotropism may even be entirely suppressed, without the process of coiling altogether disappearing.

To this Dr. J. Wortmann ** replies, maintaining that Schwendener's theory applies only to cases of coiling round a firm support, and is inadequate to explain circumnutations, free coilings, and homodromous torsions.

* SB. K. Preuss. Akad. Wiss., 1886, pp. 651–62. Cf. this Journal, 1880, pp. 117, 480; 1881, p. 479; 1882, pp. 220, 818; 1886, p. 825.

† SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 92.

‡ See this Journal, 1885, p. 837; 1886, p. 1015. § Ibid., 1886, p. 825.

‖ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 663–72.

¶ See this Journal, 1886, p. 283.

** Bot. Ztg., xliv. (1886) pp. 601–12, 618–25, 633–42, 649–58, 665–73, 681–90 (3 figs.).

Further observation has convinced him that rotating nutation or circumnutation is not an independent or spontaneous movement, but that it arises from the co-operation of at least two factors, negative geotropism and an external or internal force, which factor displays itself in the unequal growth of the two sides of every growing and rotating stem or tendril. In every growing zone, even the youngest, of internodes capable of coiling, there is a sensitiveness to the action of gravitation; in other words, every such zone is negatively geotropic; and this combines in its effects with the homodromous or transverse curvature resulting from the unequal growth above referred to, which Wortmann proposes to call the "flank-curvature" (Flanken-Krümmung). According as the right or left side grows the faster, the organ in question curves to the left or the right respectively. This movement he regards, not as geotropic, but as purely spontaneous.

Commenting on the same paper, Herr F. Noll * justifies his distinction of different kinds of coiling into simple and complicated, "clasping movement" and torsion taking no part in producing the former.

Absorption of Water in the fluid state by Leaves.—Herr L. Kny † refers to statements made by different writers as to the power possessed, under certain circumstances, by the aerial organs of many plants, to absorb water in the fluid condition, especially those of Lundström, whose results he is unable to confirm. Among a number of plants examined, *Dipsacus laciniatus* and *Fullonum* were the only ones which manifested this faculty. In these plants the small quantity of water absorbed by the leaves could only be of the very slightest advantage to the mature leaves, though it might be to the upper portion of the stem and the leaves of the terminal bud and inflorescence.

To this Herr A. N. Lundström ‡ replies that, while he is able to state with confidence that some plants, e. g. *Stellaria media*, do under certain conditions absorb water through the leaves, he has not maintained this to be a universal phenomenon; but that the most important direct beneficial effects of rain and dew on the leaves of plants consist in washing the leaves and in regulating the transpiration in the way of either increase or diminution.

(7) Chemical Processes (including Fermentation).

Moist Gangrene of the Cauliflower.§—Prof. O. Comes has investigated the cause of this disease, very prevalent in the neighbourhood of Naples, which manifests itself in all the vessels being filled with gum. He finds in the plants attacked the parasitic fungus *Pleospora Napi* or its conidiiferous form *Sporidesmium exitiosum*, generally considered to be the cause of the disease, as well as *Cladisporium* and *Macrosporium Brassicæ*; but regards these fungi as merely accessory phenomena; and believes the source of the disease to be gummy degeneration and putrid fermentation of the tissues, caused by too great richness of the soil, and a too abundant supply of water.

Exchange of Gases by Buds.‖—M. L. Mangin has experimented on the changes produced in the surrounding atmosphere by recently detached buds of various trees. The results vary with different species. As a

* Bot. Ztg., xliv. (1886) pp. 738–40.

† SB Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot Centralbl., xxviii. (1886) p. 125.

‡ Bot. Centralbl., tom. cit., p. 317.

§ Atti R. Ist. Incorragiamento Sci. Nat., iv. (1885). See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 128.

‖ Bull. Soc. Bot. France, viii. (1886) pp. 185–90.

general result, the exchange of gases is in autumn feebler in leaves than in buds, and, in the case of leaves, diminishes rapidly before their fall. In the few weeks or days preceding the fall of leaves an energetic oxidation takes place in their tissues. On the other hand, the proportion $\frac{CO_2}{O}$ remains below unity in certain cases, as the elm and lilac, during the winter period, while in others it rises almost to unity in the spring. In some, as the cherry, the proportion diminishes rapidly at the moment of unfolding of the buds. The oxidation which takes place in buds in winter appears at this period to decrease rapidly in intensity.

γ. General.

Sorauer's Handbook of the Diseases of Plants.* —The first part of the second greatly enlarged edition of this work treats of those diseases of plants which are not due to parasites, and is divided into eight chapters, as follows:—(1) Diseases caused by unfavourable conditions of nutrition; (2) by unfavourable atmospheric conditions; (3) by injurious gases and fluids; (4) by wounds; (5) formation of knots; (6) galls; (7) diseases due to deliquescence; (8) to weeds.

Prehistoric Plants.† —In his address to the Biological Section of the British Association (Birmingham Meeting), Mr. W. Carruthers first described the wonderful state of preservation of the flowers obtained by Dr. Schweinfurth from mummy-wrappings in Egypt, even such evanescent colours as the violet of the larkspur and knapweed, and the scarlet of the poppy, the chlorophyll-remains in the leaves, and the sugar in the pulp of the raisins, being preserved. The remains of 59 species of flowering plants have been identified.

In stratified clays resting on the boulder clay in the valley of the Nile, have been found the remains of 2 species of Desmidieæ, 31 of Diatomaceæ, and 9 of flowering plants, all belonging to the existing agrarian flora. In another locality 51 species of moss have been determined with certainty, a considerable proportion being alpine plants, one of them no longer found in Britain. These beds also contain 7 species of seaweed now found in our seas.

The sedimentary deposits at Cromer, of later date than the Pliocene strata, are the earliest in which remains of plants have been found that can certainly be identified with species existing at the present time. Some of the plant remains from Tertiary strata have been referred to still living species, but, as Mr. Carruthers thinks, without sufficient evidence.

Strasburger's Practical Botany.‡—This world-renowned book which has already been translated into French and even Russian, is now issued in English, having been translated by Prof. W. Hillhouse. The author has revised the translation and partly rewritten some portions. There are many additional notes both by author and editor, those of the editor being intended to either simplify or amplify the description or to enable the material selected by the author to be replaced by some other, probably more readily obtainable. The introduction on instruments and apparatus he has nearly rewritten, to make it more suited for English students.

* Sorauer, P., 'Handb. d. Pflanzenkrankheiten,' 2te Aufl., 1er Th., 920 pp., 19 pls., and 61 figs.

† Journ. of Bot., xxiv. (1886) pp. 309–18.

‡ See this Journal, 1885, p. 332. Engl. ed., 8vo, London Swan, Sonnenschein, Lowry and Co., 1887.

The design of the book is sufficiently shown by the opening paragraphs of the author's preface.

"This book is intended for those who, without desiring to become botanists by profession, wish nevertheless to become acquainted with the elements of scientific structural botany. It will likewise introduce the beginner to the various methods of microscopical manipulation.

The study of vegetable structure is especially favourable as an initiation into the use of the Microscope; and any one whose future career will require command over this instrument should commence with the study under the Microscope of vegetable anatomy.

The manual is divided into thirty-two chapters, each of which is intended to provide materials for several hours' practical work in the laboratory. The earlier chapters are easy, and the difficulties to be encountered increase almost continually up to the last chapter. The first chapter assumes on the part of the worker entire ignorance as to the use of his instruments, but nevertheless assumes the possession of some general botanical knowledge. With this elementary preparation the beginner ought to be able, by the diligent use of this book alone, to acquire a tolerably broad knowledge both of vegetable structure and of the methods of microscopical work."

In our notice of the original work we characterized it as "extremely useful"; experience has proved that this was but faint praise. In its improved English form it will take an even higher place as a leading handbook for microscopical manipulation.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Fertile Shoots of Equisetum.*—According to Herr K. Goebel the fertile shoots of all those species of *Equisetum* in which these shoots differ in structure from the barren shoots, result from the transformation of the latter, both in a phylogenetic and in an ontogenetic sense, due to an arrest of development. The difference consists essentially in the absence of chlorophyll, the suppression of branching, the temporary duration of the stem, and the absence of stomata; as well as in the greater development of the sheaths, which is difficult to explain from a biological point of view. This view is confirmed by the fact that it is possible artificially to induce the fertile shoots of *E. arvense* to put out green branches from the lower internodes, chlorophyll being also formed in the main axis. This may occur even in nature, producing the forms known as *E. irriguum* and *riparium*. There is therefore no sharp line of demarcation to be drawn between the two sections of the genus known as "homophyadic" and "heterophyadic."

Ulodendron and Bothrodendron.†—M. R. Zeiller agrees with Kidston in arranging the fossil structures hitherto classed under *Ulodendron* in three groups, and in referring the first to *Lepidodendron*, and the second to the genera *Ulodendron* and *Rhytidodendron*, the latter including the *Bothrodendron* of Lindley and Hutton; but he does not accept Kidston's view that the structures classed under *Ulodendron* belong to the section *Clathraria* of *Sigillaria*. They are distinguished from these by the leaf-scars being contiguous and arranged in oblique series.

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 184–9.

† Bull. Soc. Geol. France, xiv. (1886) pp. 168–82 (2 pls.). See Bull. Soc. Bot. France, 1886, Rev. Bibl., p. 108.

Fossil Rhizocarps.*—Sir W. Dawson describes the organs of fructification of cryptogams obtained from the Erian (Devonian) formation in Canada and the northern United States. He now regards the organisms previously described as sporangia under the name of *Sporangites*, and placed under Lycopodiaceæ, as more nearly allied to the Rhizocarpeæ and especially to *Salvinia*. He prefers for the whole group the name previously suggested by him, *Protosalvinia*, though it probably includes several genera of Rhizocarpean affinities. The detached discs may be regarded as macrospores, and their cellular envelopes as sporocarps. The diagnoses are now given of five species, viz. *P. huronensis*, *brasiliensis*, *bilobata*, *Clarkei*, and *punctata*. Sir W. Dawson believes the rhizocarpean macrospores to be the cause of the highly bituminous character of the shales which are charged with them, though there are shales which depend for their inflammable matter on microscopic debris of an entirely different character.

Muscineæ.

Capsule of Mosses as an Assimilating Organ.†—Herr F. Magdeburg has examined the structure and functions of the loose air-containing tissue found in the capsule of a large number of mosses between the outer wall and spore-sac or foot of the columella, the intercellular spaces being especially developed at the neck and apophysis, where also are the greater number of stomata. That this development is not connected with the absorption of moisture is shown by the fact that it is least marked in those mosses which grow in water or in very wet places, such as *Climacium*, *Dicranum palustre*, *Rhynchostegium rusciforme*, *Aulacomnium palustre*, &c., while those which grow in dry habitats, as *Grimmia pulvinata*, *Funaria hygrometrica*, *Polytrichum piliferum*, and species of *Barbula* and *Bryum*, display it to a considerable extent. For the same reason it is obviously not connected with the process of transpiration; and similar objections apply to its being associated with respiration.

The author then adduces reasons for connecting the development of this tissue with the process of assimilation; the chief reasons being the abundance of chlorophyll which it contains, and the presence of a large number of stomata.

The structure of the capsule of a considerable number of species is described in detail; and it is pointed out that the form of this organ is chiefly determined by its assimilating character, its complication of structure being in proportion to the development of the latter. In the Cleistocarpeæ, Sphagnaceæ, and Andreæaceæ the power of assimilation of the capsule is reduced to a minimum; while in *Polytrichum*, *Bryum*, *Mnium*, and other erect Stegocarpeæ it is very considerable. In proportion to the development exhibited by mosses is the independence of the sporogonium.

This power of assimilation resides to the greatest extent in the spore-sac, next in the innermost layers of the wall of the capsule, and finally in the characteristic tissue of the apophysis or neck.

Muscineæ of Central Africa.‡—Mr. W. Mitten describes the Mosses and Hepaticæ collected by the late Bishop Hannington in Central Africa, and by Mr. H. H. Johnston on Kilimanjaro, including a large number of new species.

* Bull. Chicago Acad. Sci., i. (1886) pp. 105-18 (1 pl.).

† Magdeburg, F., 'Die Laubmooskapsel als Assimulationsorgan,' 32 pp. and 2 pls., Berlin, 1886.

‡ Journ. Linn. Soc. Lond. (Bot.)., xxii. (1886) pp. 298–329 (5 pls.).

Classification of Sphagnaceæ.*—Pursuing his researches on the classification of Sphagnaceæ, Dr. Röll adopts Schliephacke's arrangement of the species under 7 heads, viz. I. Acutifolia, 2. Cuspidata, 3. Squarrosa, 4. Rigida, 5. Mollusca, 6. Subsecunda, 7. Cymbifolia. The species are then arranged as follows:—(1) *Schimperi* W., *Schliephackeanum* W., *acutifolium* Ehrh., *Wilsoni* n. sp., *plumulosum* n. sp., *fuscum* Kl., *Warnstorfii* n. sp., *robustum* Russ., *Girgensohnii* Russ., *fimbriatum* Wils., *Wulfii* Girg. (2) *Lindbergii* Sch., *riparium* Angs., *Limprichtii* n. sp., *recurvum* Pal., *intermedium* Hoffm., *cuspidatum* Ehrh., *laxifolium* Müll. (3) *teres* Angs., *squarrosum* Pers. (4) *rigidum* Sch., *molle* Sull., *Angströmii* Hart. (5) *tenellum* Ehrh. (6) *laricinum* Spr., *subsecundum* Nees, *contortum* Schltz., *turgidum* Müll., *platyphyllum* Sull. (7) *medium* Limp., *glaucum* Kling., *cymbifolium* Hedw., *subbicolor* Hpe., *papillosum* Lind., *Austini* Sull. Under each species the varieties and subvarieties are minutely described, and a table given of the probable genetic relationship of the various forms.

European Sphagnaceæ.†—M. J. Cardot classifies the Sphagnaceæ of Europe under thirteen species, recognizing as a species any group of forms distinguished by morphological characters of sufficient importance which are constant, and which do not pass by insensible gradations into those of another group. Where a group is marked by characters not of such absolute constancy, and which do in some cases pass into those of another group, he regards such a group as a sub-species. The characters chiefly relied on are those of the cauline leaves, the epidermis of the stem, a transverse section of the branch-leaves, and those of the lageniform cells; discarding altogether, as of no specific value, characters derived from the presence or absence of fibres in the cauline leaves, from the capsule and perichætial leaves, or from the inflorescence.

On these principles the European Sphagnaceæ are grouped as follows:—Group I. Sphagna cymbifolia. 1. *S. cymbifolium* Hedw. (subsp. medium Limpr., papillosum Lindb., Austini Sulliv.). Group II. Sphagna truncata. 2. *S. Angstrœmii* Hartm. 3. *S. rigidum* Sch. 4. *S. molle* Sulliv. Group III. Sphagna subsecunda. 5. *S. tenellum* Ehrh. 6. *S. subsecundum* N. v. Ees. (subsp. laricinum Spr.) 7. *S. Pylaiei* Brid. IV. S. acutifolia. 8. *S. teres* Angstr. (subsp. squarrosum Pers.). 9. *S. fimbriatum* Wils. 10. *S. acutifolium* Ehrh. (subsp. Girgensohnii Russ.). 11. *S. Wulfianum* Girg. V. S. undulata. 12. *S. Lindbergii* Sch. 13. *S. recurvum* P. B. (subsp. cuspidatum Ehrh.).

New Hepaticæ.‡—Herr V. Schiffner describes three new species of Hepaticæ from Hänke's collection, viz. *Lejeunia repanda* and *L. perforata* from Mauritius, and *Phragmicoma Hœnkeana* from Mexico; also a monœcious species of *Riella*, *R. Battandieri*, from Algeria. He considers *Riella* as departing from all other genera of Hepaticæ in the absence of a bilateral structure. Archegonia and leaflets occur not unfrequently, not only on both faces of the wings, but even on the side of a rib opposite to a wing.

Algæ.

Alga parasitic on animals.§—Dr. A. Peter describes a new species of alga which he finds forming flat discs about 12 mm. in diameter on the carapace and other parts of *Emys europæa*. The systematic position of the alga,

* Flora, lxix. (1886) pp. 33–47, 73–80, 89–94, 105–11, 129–37, 179–87, 227–42, 328–37, 353–70, 419–27, 467–76 (1 pl.). Cf. this Journal, 1886, p. 108.

† Bull. Soc. R. Bot. Belg., xxv. (1886) pp. 19–136 (2 pls.).

‡ Bot. Centralbl., xxvii. (1886) pp. 207–11, 239–43 (1 pl.).

§ SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot. Centralbl., xxviii. (1886) p. 125.

for which he proposes the name *Dermatophyton radians*, is uncertain. The mode of growth resembles that of *Coleochæte;* but it forms a continuous parenchyma with thick cell-walls, resulting from repeated horizontal divisions of all the cells cut off from the marginal cells and from intercalary divisions. The lowest cell of each of these erect rows elongates below to a wedge-shaped form, and penetrates into the horny tissue of the shell, as the marginal cells of the whole plant do. By this means the shell is broken up into lamellæ. The mode of reproduction is not described.

Algæ epiphytic on Nymphæaceæ.*—Sigg. G. B. de Toni and D. Levi have examined the algæ found attached to the leaves of *Nymphæa alba* and *Nuphar lutea* in the botanic garden at Padua. They find 39 species in all, of which 19 are new to the Venetian flora. They comprise 24 species of diatoms, 2 Chroococcaceæ, 2 Oscillariaceæ, 1 Rivulariacea, 1 Coleochætacea, 2 Œdogoniaceæ, 1 Volvocinea, 5 Protococcaceæ, and 1 Conjugata.

Action of Algæ upon Water.†—According to M. E. Bréal, the microscopic algæ in fresh water decompose bicarbonate of lime dissolved in the water, and thus give rise to a calcareous deposit. Being able to live in neutral or slightly alkaline liquids, they may, by the oxygen which they disengage, serve to oppose or even arrest putrefaction. They rapidly remove nitrates and ammonia from water, since these two substances supply the nitrogen necessary to their growth; in the dark, however, liquids charged with these algæ evolve ammonia.

Prolification of Caulerpa.‡—Dr. J. H. Wakker has investigated this phenomenon in cultures of *C. prolifera* from the Bay of Naples, and finds that it may take place abundantly in each of the parts of the very large single cell which represent physiologically the rhizome, the roots, and the foliage of higher plants. In the "leaf" he has found as many as eleven successive prolifications in connection with one another. Dr. Wakker suggests that the production by *Caulerpa* of zoospores, which has very seldom been observed, is extremely rare, and that the chief mode of reproduction to which is due its very extensive growth, is this prolification. The author's researches are opposed to the conclusion of Sachs that the roots of plants grow only at their base, and buds at their apex, and that the direction is determined by the force of gravity.

Hildebrandtia and Dichosporangium.§—Herr R. Wollny has repeated his observations on the antheridia of *Hildebrandtia*, but suggests that when the mode of reproduction is fully known, it will be found that the plant described by him really belongs to *Peyssonellia*.

He also describes a new species of Ectocarpaceæ, *Dichosporangium Chordariæ*, with both unilocular and multilocular zoosporangia.

Hauck and Richter's Phycotheca universalis.—The first part is now issued of this very useful and valuable publication, consisting of dried specimens of fifty species of fresh-water and marine algæ, belonging to a great number of different orders.

Terrestrial species of Ulothrix.‖—M. E. de Wildeman describes in detail the two terrestrial species of *Ulothrix* (*Hormidium* Ktz.), *U. radicans* and *U. parietina*, especially the "radicles" characteristic of the former

* Malpighia, i. (1886) pp. 60–7.

† Ann. Agronom., xii. (1886) pp. 317–32. Cf. Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 1060.

‡ Versl. en Meded. K. Akad. Weten. Amsterdam, 1886, pp. 251–64 (1 pl.).

§ Hedwigia, xxv. (1886) pp. 125–32 (3 pls.). See this Journal, 1886, p. 659.

‖ Bull. Soc. R. Bot. Belg., xxv. (1886) pp. 7–18 (1 pl.).

species, which are insufficiently described and figured, and which appear to be the sole constant character by which the two species can be distinguished. He confirms Dr. Braxton Hicks' statement of the development of a *Ulothrix* or *Schizogonium* from a *Pleurococcus*. The radicles of *U. radicans* are replaced in *U. parietina* by branches.

Algæ of Bohemia.*—In the first part of this important work, Dr. A. Hansgirg treats of the general classification of Algæ. Excluding the Diatomaceæ, he adopts, in its main features, Rabenhorst's four classes of Rhodophyceæ, Phæophyceæ, Chlorophyceæ, and Cyanophyceæ. Under the Phæophyceæ he includes the Syngeneticæ (*Chromophyton* and *Hydrurus*), nearly allied to which are the Phæozoosporeæ (*Lithoderma*). The Chlorophyceæ he divides into Confervoideæ, Siphoneæ, Protococcoideæ, and Conjugatæ. The oogamic Confervoideæ are arranged under the families Coleochætaceæ (*Coleochæte* and *Herposteiron*), Œdogoniaceæ (*Œdogonium* and *Bulbochæte*), and Sphæropleaceæ (*Sphæroplea*); the isogamous Confervaceæ under Ulvaceæ (*Prasiola*, *Enteromorpha*, and *Schizomeris*), Chætophoraceæ (*Ulothrix*, *Stigeoclonium*, *Chætophora*, and *Draparnaldia*), Cladophoraceæ (*Conferva*, *Rhizoclonium*, and *Cladophora*, and Trentepohliaceæ (*Trentepohlia*, *Chlorotylium*, and *Microthamnion*). *Botrydium* he places under Siphoneæ.

In a separate paper,† Dr. Hansgirg enumerates the algæ found in the salt lakes and marshes of Bohemia. They are very numerous, and include representatives of nearly all the forms of Chlorophyceæ; but very few of the species are peculiar to these localities.

Structure of Diatoms.‡—Mr. H. Morland supports the view that in *Navicula Durrandii* the dots are nothing but minute perforations; but he cannot regard the median line or raphe as merely a thickening for strengthening the valve generally; he considers it, on the contrary, to be simply a cleft with thickened borders. In this species he has sometimes noticed, when examining the raphe, that it has two borders, in consequence of the cleft being slightly oblique, one of which, under a high power, will be seen to be on the "upper" surface, while the other is on the "inner" surface; but if the ends of these borders be examined, it will be found that they join each other. The same is the case in *Pleurosigma balticum*.

By the examination of carefully prepared sections of Jutland "cementstein," § Mr. Morland confirms Prinz and Van Ermengem's statements with regard to the structure of the diatoms contained in it. The markings on the diatom-valves are seen to be perforations, although the structure differs in different forms. The author proceeds to describe the variations found in *Coscinodiscus oculus-iridis*, *Trinacria regina*, *Pyxidicula cruciata*, *Stictodiscus Jeremianus*, *Arachnoidiscus Ehrenbergii*, and *Aulacodiscus margaritaceus*. Of these he considers *Trinacria regina* to be one of the simplest, while the structure of *Aulacodiscus margaritaceus* is highly complicated; but in all the markings are seen, if carefully examined, to be perforations.

Lichenes.

Soredial sporidia of Amphiloma murorum.‖—Sig. A. Borzì identifies the gonidia of this common wall-lichen with *Hormidium varium*. He describes a peculiar mode of reproduction of the soredia which he observed in very wet weather. Unicellular conidia from 2 to 4 μ in diameter were

* Hansgirg, A., 'Prodromus der Algenflora von Böhmen,' Heft 1, Prag, 1886. See Oesterr. Bot. Zeitschr., xxxvi. (1886) p. 313.

† Oesterr. Bot. Zeitschr., xxxvi. (1886) pp. 331–6.

‡ Journ. Quek. Micr. Club, ii. (1886) pp. 297–307. § See *infra*, Microscopy β.

‖ Malpighia, i. (1886) pp. 20–4.

formed laterally or terminally on the hyphæ by the transformation of single hyphal cells, and detached themselves from the hyphal cortex of the soredium. These detached conidia readily germinated in the surrounding water. If the germinating filament came into contact with an isolated cell of *Hormidium*, it completely invested it, branching abundantly, the algal cell dividing at the same time, under the influence of the parasite, into four, eight, or sixteen, thus giving birth in a short time to a new soredium. If the germinating filament came into contact with a filament of *Hormidium*, the latter also became completely invested, and the cells of the filament separated and broke up into the coccus form, thus furnishing the gonidia for the new soredia.

Micro-chemistry of Lichens.*—Herr K. B. J. Forsell has tested a number of lichens and fungi for lignin by the phloroglucin and hydrochloric acid test, but in all cases with negative results. Some lichens, as *Lobaria pulmonaria* and *Lecanora pallescens*, took sooner or later a red tinge with indol and sulphuric or hydrochloric acid; but since the same result was obtained with potato-starch, gum arabic, cotton, and cane-sugar, this cannot be regarded as a reliable test for lignin. The author found that the hyphæ of lichens occasionally took a slight red tinge with sulphuric acid alone, without indol. This the author explained by the conversion of the lichenin into sugar by the acid, the sugar then giving Raspail's reaction with the acid in the presence of albuminoids.

Fungi.

Cell-nuclei in the Hymenomycetes.†—M. L. K. Rosenvinge has examined a large number of species of Hymenomycetes, with the object of determining the presence or absence of a nucleus in the cells. The staining reagent used was hæmatoxylin on material hardened in alcohol, but its use was often attended with difficulties.

The author finds that, as a general rule, all the cells of the Hymenomycetes contain nuclei, though, under certain circumstances, they may disappear with the protoplasm. In the adult cells of the ordinary hyphæ there are generally several nuclei; in the young cells there is probably only one, at least in some species. In the young basidia there is always only one. The cystidia also contain at first only a single nucleus, which may subsequently divide into several. A nucleolus can always be detected, especially in the nuclei of the basidia. In some genera the nucleus has a vesicular appearance, the chromatin accumulating at its periphery. The only case in which an indication of indirect division of the nucleus was observed by the author was in the basidia of *Tricholoma virgatum*. The nucleus of the basidia ordinarily divides into four or eight, double the number of the spores, which are formed all at the same time. The protoplasm and the nuclei pass from the basidium into the spores, which thus contain either one or two nuclei. If the spore contains only a single nucleus, its diameter considerably exceeds that of the sterigma. If it has two spores, these are smaller, their substance also being less dense. The change of form of the nuclei, in passing into the spores, is passive, being caused by the obstacle offered by the cell-wall of the sterigma.

The mode of formation of the spores in the Hymenomycetes is an example of cell-division. The two or four (rarely three or six) daughter-cells are formed in the lower part of the basidium or mother-cell, the

* SB. K. Akad. Wiss. Wien, xliii. (1886) pp. 219–30.
† Ann. Sci. Nat. (Bot.), iii. (1886) pp. 75–93 (1 pl.).

contents of which, protoplasm and nucleus, are entirely used up in the formation of the daughter-cells; nothing of the mother-cell remains except its wall.

Poisonous principles of Hymenomycetous Fungi.*—Herren R. Böhm and E. Külz find choline, the poisonous principle of *Amanita muscaria*, present also in *A. pantherina* and *Boletus luridus*, to the extent of 1 per cent. of the dry substance. In *Helvella esculenta* they found also an apparently identical base. In *A. pantherina* were found considerable quantities, in *B. luridus* much smaller quantities, varying with the season, identical in its properties with the muscarine of *A. muscaria;* the former species must be regarded as poisonous; *B. luridus* as suspicious, but often harmless.

In *Helvella esculenta*, which is frequently poisonous, the authors found a poisonous acid with the composition $C_{12}H_{20}O_7$, which they call *helvellic acid;* and in *B. luridus*, an acid to which they give the name *luridic acid*, easily obtainable in stable wine-red crystals, containing no nitrogen; it is probably the characteristic pigment of this fungus. In *A. pantherinus* was found a crystallizable acid of very similar composition, which the authors call *pantherinic acid.*

Schulzeria, a new genus of Hymenomycetes.†—Under this name Sig. S. G. Bresaloda describes a new genus of Agaricini belonging to the group Leucospori. It is distinguished from *Lepiota* by the absence of an annulus, presenting therefore a parallel genus to *Pluteus* and *Pilosaca.* In addition to the above, it is characterized by the absence of a volva, by the pileus being differentiated from the stipes, and by the lamellæ being rounded behind and quite free from the stipes. The author describes two species, *S. rimulosa* and *squamigera*, both from Slavonia.

Lycogalopsis Solmsii, a new Gasteromycete.‡—Under this name Herr E. Fischer describes the type of a new genus of Gasteromycetes gathered in Java by Graf Solms-Laubach. He places it between the Lycoperdaceæ and Hymenogastreæ, near to *Scleroderma.* The fructification has a peculiar laminated appearance, owing to the repeated cessation of growth of the weft of hyphæ of which it is composed; the denser portions of this weft not unfrequently inclose solid foreign bodies. The development of the gleba is described in detail. The spores are from 3 to 4 μ in diameter, of a nearly spherical or more irregular form, sessile or shortly stalked, 6–7 formed on each basidium, with a thick outer membrane; and they escape in the form of a fine powder when the rest of the gleba deliquesces. A rudimentary formation of capillitium is to be detected.

New Aspergillus.§—Dr. F. Morini describes a new species of this genus, or of *Sterigmatocystis*, which should probably be incorporated in it. It was found in a greenhouse, on *Ozonium auricomum*, forming bright blue spots just visible to the naked eye. Each of these spots consists of a bundle of filaments, from 105 to 150 μ in length, gradually narrowing upwards. Near the apex of each filament is a septum, and at the summit it branches into a nearly globular cluster of minute elliptical hyaline spores, about 4–5 μ long by 1·3–1·5 μ broad. These spores are arranged in chains springing from sterigmata 10–12 μ long, themselves seated on

* Arch. f. Expér. Pathol u. Pharmacol., xix. (1885). See Bot. Ztg., xliv. (1886) p. 642.

† Bresaloda, S. G., 'Schulzeria, nuove genere d'Imenomiceti,' 9 pp. and 1 pl., Trient, 1886.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 192–7 (1 pl.).

§ Malpighia, i. (1886) pp. 24–31 (1 pl.).

a kind of oval basidium, 7–8 μ long and 5–6·5 μ broad. The fungus was cultivated for several generations without producing any but the conidial form.

Diseases of Cultivated Plants.*—Dr. E. Rostrup has observed, in several places in the neighbourhood of Copenhagen, a hitherto undescribed fungus parasitic on barley, to which he gives the name *Scolecotrichum Hordei*, nearly allied to *S. graminis*. The disease takes the form of white strips on the leaves and stem. These strips are covered by fine grey dots which are masses of hyphæ projecting through the stomata. Each hypha bears a single, comparatively large, oblong, light yellow, bilocular conidium.

A *Rhizoctonia* was found to be a very widely spread enemy of clover, *Medicago sativa*, *M. lupulina*, *Rumex*, and *Geranium*. On clover plants from Norway a new species, *Typhula Trifolii*, was detected, and a *Rhizoctonia* on the potato.

Diseases caused by Fungi.†—Dr. E. Rostrup groups under the name "mycocccidia" the diseases of the nature of hypertrophy of tissue caused by parasitic fungi. As a general rule the Myxomycetes (*Plasmodiophora* and *Schinzia*) give rise to excrescences on the stem and roots. The Peronosporeæ cause curvature of the stem and patches on the leaves.

The author also describes the following new species:—*Physoderma deformans* on the flowers of *Anemone nemorosa*; *Taphrina Tormentillæ* on *Tormentilla erecta*; *T. Umbelliferarum* on *Heracleum Sphondylium* and *Peucedanum palustre*; *Fusarium amenti* on the catkins of *Salix cinerea* and *aurita*; and *Exobasidium Oxycocci* on *Oxycoccus palustris*.

Asteroma of the Rose.‡—Herr B. Frank describes the disease caused by this parasite in rose plantations, which differs from both the mildew and rust of roses. It manifests itself in circular dark greyish-brown spots, about 1 mm. in diameter, scattered over the whole upper surface of the leaf. The species is *Asteroma* or *Actinonema radiosum* Fr. It is distinguished by its radiating filaments which run beneath the cuticle, become septated and branched, and thence penetrate into the internal tissue of the leaf. The fructification is formed beneath the cuticle in the form of minute dark dots. The spores are from 0·015 to 0·018 mm. in length, two-celled and colourless, and germinate directly. The injurious effect of the parasite is shown in the formation of a brown or yellow resinous mass or of drops in the epidermal cells, the adjacent cells of the parenchyma also perishing. The disease sometimes extends to the under side, and the spores are very readily carried by rain or dew.

Gnomonia erythrostroma, a cherry-parasite.§—Herr B. Frank has investigated the cause of a disease which is exceedingly destructive to cherry-trees on the Lower Elbe, taking the form of yellow spots on the leaves, which gradually increase in number and size, causing the leaves to die without falling off, and finally killing the tree. He finds it due to the attacks of a parasitic fungus, *Gnomonia erythrostroma* Fkl. (*Sphæria erythrostroma* Pers.). The perithecia ripen in the spring, when the ascospores, of which eight are formed in each ascus, are violently thrown out of the asci in the same way as in *Chætomium*, this being the mode in which the

* In Danish, Copenhagen, 1886. See Bot. Centralbl., xxviii. (1886) p. 106. Cf. this Journal, 1886, p. 299.

† Bot. Tidsskr Kjobenhavn, xiv. (1885) pp. 21–6. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 99.

‡ Frank, B., 'Ueb. d. Rosen-Asteroma, einen Vernichter d. Rosenpflanzungen,' 1885 (16 pp. and 5 figs.). See Bot. Centralbl., xxvii. (1886) p. 294.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 200-5.

disease is propagated, the ejection taking place in wet weather only. *Gnomonia* furnishes another example of sexual reproduction among the Pyrenomycetes, the author having distinctly observed the production of the perithecia as the result of the impregnation of a trichogyne by spermatia in the same way as in *Polystigma*. The spermogonia are formed in the spongy parenchyma, the spermatia having the form, as in *Polystigma*, of long slightly curved threads. Several spermatia appear to impregnate a single trichogyne. The spores germinate at once, perforate the cuticle, and, penetrating the epidermal layer of cells, develope into a mycelium in the intercellular spaces of the mesophyll. By the infected leaves remaining on the trees after being killed by the fungus, the spread of the parasite is greatly promoted.

Orange-leaf Scab.*—Mr. F. L. Scribner describes the above disease, and suggests various remedies for arresting the malady. It first makes its appearance as small wart-like excrescences on the upper or under side of the orange-leaves. These excrescences increase in number and size, until the whole surface is covered, the vitality of the leaf becoming destroyed. Upon some of the diseased specimens there was discovered a species of *Fusarium*, believed to be identical with *F. sarcochroum* Desm., the tubercles being apparently caused by the mycelium of this fungus. The hyphæ and spores are present in greater or less abundance on all the more developed excrescences.

Peronospora viticola.†—Dr. P. Baccarini describes a peculiar disease which has recently attacked vineyards in the south of France, known as "negrone" or "negrara," and manifested in the drying up of the berries which still remain attached to their stalks. He attributes the malady to a peculiar development of *Peronospora viticola* and not, as has been generally supposed, to the attacks of the American "black-rot," *Phoma uvicola*.

Mode of Destruction of the Potato by Peronospora infestans.‡—Mr. E. W. Claypole states that in a potato the vascular layer appears as a semi-transparent line running along the cut surface about 1/4 in. below the cuticle, and rising to the eyes where it meets the layer that represents the bark. At these points the cuticle is exceedingly thin, and here the assault of *P. infestans* is usually made. Its progress is marked by a black streak advancing from the eye along the layer of vascular tissue. A layer of the bark immediately under the rind is attacked in the same manner. In these two layers the life of the potato resides, and their destruction consequently insures its death.

"Black-rot" of the Vine.§—MM. P. Viala and L. Ravaz describe a disease which has attacked vineyards in France since 1885, and which is identical with the American "black-rot" produced by *Phoma uvicola*. It attacks both the leaves and the berries, causing the latter to dry up and the skin to become covered with numerous pustules. These are produced by the conceptacles of the fungus, which are of two kinds; the larger are pycnidia containing stylospores, the smaller spermogones containing slender spermatia. While the "black-rot" is due exclusively to the attacks of *Phoma uvicola*, the diseases known in America as "grey-rot," "common-rot," "soft-rot," and "brown-rot" are all caused by *Peronospora viticola*. "Black-rot" has nothing to do with anthracnose, the identification of

* Bull. Torrey Bot. Club, xiii. (1886) pp. 181–3.
† Malpighia, i. (1886) pp. 56–60. ‡ Bull. Torrey Bot. Club, xiii. (1886) p. 191.
§ Viala, P., et L. Ravaz, 'Mém. sur une nouv. maladie de la vigne,' 4 pls., Montpellier, 1886. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 129.

Phoma uvicola with a conceptacular form of *Glœosporium ampelinum* being erroneous.

The authors describe also three other parasites of the berry of the grape, *Phoma flaccida*, *P. reniformis*, and *Coniothyrium diplodella*, which have some analogy with "black-rot," but differ in causing no important injury.

Fungus of the Root of the Vine.* — Herr J. B. Schnetzler records for the first time the observation of fructification on the mycelium of *Agaricus melleus*, which is so common on the roots of diseased vines. The mycelium of *Dematophora necatrix* is also abundant in similar situations, and is not to be confounded with the former.

Fungi of Nova Zembla.†—In the collection of dried plants brought from Nova Zembla by M. Weber, Dr. C. A. J. A. Oudemans finds a large number of parasitic fungi, including the following new species:—*Pleospora Arctagrostidis* on *Arctagrostis latifolia*, *Leptosphæria Hierochloæ* on *Hierochloe alpina*, *Septoria Eriophori* on *Eriophorum angustifolium*, *Pleospora Cerastii* on *Cerastium alpinum*, *Leptosphæria Weberi*, *Sphærella nivalis*, and *Metasphæria Annæ* on *Ranunculus nivalis*, *Ascochyta Papaveris* on *Papaver nudicaulis*, *A. Drabæ* on *Draba alpina*, *Sphærella octopetalæ* on *Dryas octopetala*, *Sphærella Potentillæ* and *Microthyrium arcticum* on *Potentilla fragiformis*, *Phoma Astragali alpini* on *Astragalus alpinus*, *Phoma Polemonii* on *Polemonium pulchellum*.

Rabenhorst's Cryptogamic Flora of Germany (Fungi).—Parts 22–26 of this work are still entirely occupied with the Sphæriaceæ, the principal genera described being *Mussaria* (27 sp.), *Gnomonia* (37 sp.), *Diarporthe* (132 sp.), *Valsa* (111 sp.), *Valsella* (18 sp.), *Anthostoma* (20 sp.), *Melanconis* (20 sp.), *Calosphæria* (18 sp.), *Diatrypella* (24 sp.), and a portion of *Hypoxylon*.

Protophyta.

Relationship of the Chlorophyllous Protophyta to the Protonema of Mosses.‡—Following out the observations of Hicks § on the relationship between the gonidia of lichens and certain stages in the development of the protonema of mosses, Dr. A. Hansgirg states that it is common to find, among the Chroococcaceæ and Palmellaceæ which are so abundant on the damp walls of hothouses, branched filaments of moss-protonema, some of the cells of which resemble externally the ordinary cells of the protonema, but the contents of which are strikingly different. Some of these cells, which may also be occasionally found in the open air, contain chlorophyll-grains of a pale yellow-green colour and undefined outline imbedded in yellowish-green cytoplasm; while in others the chlorophyll-grains had entirely disappeared, and the entire cytoplasm assumed a uniform golden colour, owing to the presence of drops of a fatty oil. By pressure or the resorption of the cell-wall these cells may be set free, and may lie isolated in the surrounding mucilage. Microchemical reactions indicate that the contents probably consist partly of a fatty oil, partly of reduced chlorophyll. Such isolated cells commonly still retain their cylindrical form, and bear a close resemblance to *Cylindrocystis*. In some of these cells the author observed the green pigment more or less collected in the centre of the cell, while in others were two eccentric nucleus-like bodies or well-

* Bot. Centralbl., xxvii. (1886) p. 274.

† Versl. en Medded. K. Akad. Weten. Amsterdam, 1886, pp. 146–62 (3 pls.).

‡ Flora, lxix. (1886) pp. 291–303.

§ Quart. Journ. Micr. Sci., 1861; Trans. Linn. Soc. Lond., 1862; and Trans. R. Micr. Soc., 1864, p. 257.

developed star-shaped chromatophores with distinct globular pyrenoids. They bear a very close resemblance to the *Mesotænium* form of *Palmoglœa* in the condition in which the cells are found after long-continued dry weather. Between these cells and the ordinary cells of the moss protonema are all grades of transition.

This retrogressive metamorphosis of the protonema occurs with several species of moss, especially when growing in moist slimy situations. Under favourable conditions the cells are capable of vegetative bipartition, commencing with the pyrenoids and chromatophores. It has been pointed out by Schmitz * that pyrenoids occur as low down as the Anthoceroteæ, and by the present author † that they are found in the Phycochromaceæ when in a state of retrogressive metamorphosis, but not when in the ordinary filiform condition.

The general conclusions drawn from these observations by the author is that the Phycochromaceæ must no longer be regarded as the primitive form of algæ, their half-saprophytic mode of life and the occurrence of highly organized substances imbedded in their protoplasm indicating their true position as derivatives from higher forms of life by retrogressive metamorphosis.

Acanthococcus.‡—Herr P. F. Reinsch gives a full description of this genus of Palmellaceæ, founded by Lagerheim on Reinsch's *Pleurococcus vestitus*. Fourteen species are described, twelve of them new, obtained from gatherings in Germany, Scandinavia, and the United States. They appear to be extremely abundant in fresh water among larger algæ, and are probably generally mistaken for the zygospores of desmids, though often to be seen at periods of the year when these are not to be met with. The structure and biology of *Acanthococcus* differ but little from those of *Palmella*. The perfect cell divides into 8–16 daughter-cells, which remain but a short time in connection, being set free by the deliquescence of the outer membrane. After this breaking up, the gelatinous outer layers of the daughter-cells undergo a variety of changes, developing into warts, spines, and other prominences characteristic of the genus and of the different species; this being their resting condition. After hibernation these divide into 4–8–16 daughter-cells with smooth walls. They are best distinguished from the zygospores of desmids by the nature of their cell-wall, and by containing, when mature, coloured drops of oil instead of vacuoles of water.

Sphærogonium, a new genus of Phycochromaceæ.§—Dr. J. Rostafinski describes seven species of this new genus nearly allied to *Chamæsiphon*, but differing from it in being unicellular. These two genera, together with *Clastidium* and *Dermocarpa*, make up the family Chamæsiphoneæ.

New Hæmatococcus.‖—Dr. F. Blochmann describes a new species of this genus to which he gives the name *Hæmatococcus Bütschlii*, corresponding in the main in its history of development to *Chlamydomonas*. It differs, in the swarming condition, from *H. pluvialis* in having no distinct chromatophore, and in possessing numerous much-branched pseudopodia of a uniform green colour. In the centre of the protoplasmic body is the

* See this Journal, 1883, p. 405. † See this Journal, 1885, p. 691.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 237–48 (2 pls.). Cf. this Journal, 1884, p. 273.

§ R. i. S. Akad. Krakau, x. (1883) pp. 280–305 (1 pl.). See Bot. Centralbl., xxvii. (1886) p. 352.

‖ Ber. Heidelberg. Med. Naturh. Ver., 1886 (22 pp. and 2 pls.). See Bot. Ztg., xliv. (1886) p. 676. Cf. this Journal, 1886, p. 1006.

nucleus, with two pyrenoids, one before and one behind it. At the anterior end is a conspicuous crescent-shaped red "stigma." At the anterior pole are also two vibratile cilia projecting through small tubes in the membrane.

Vegetative division takes place in the night, the contents dividing first into two and then into four, the pseudopodia being withdrawn. The four daughter-cells then surround themselves each with a delicate cell-wall, and each developes two cilia, the cilia of the original individual still remaining attached to its membrane after the daughter-cells escape from it. The stigma of the original cell occupies a posterior position in one of the daughter-cells, the stigmas not being developed in the others till after their escape. A reversal of the poles and of the direction of movement takes place on each division.

The formation of microgonidia takes place in the latter part of the day, the first stages of the process being the same as in vegetative division, but the bipartition continues until 32 or 64 distinct bodies are formed, the stigma eventually entirely disappearing. The microgonidia thus formed are about 1/10 the size of the ordinary swarming cells; they are pear-shaped or fusiform with a hyaline anterior and pale green posterior end; at the former end is an obscure stigma and two cilia; they have no membrane. Conjugation takes place as soon as they escape from the mother-cell, and microgonidia from the same mother-cell may unite; they lose their cilia and develope a cell-wall of cellulose. The resulting resting-cell acquires a red colour from the formation of hæmatochrome, and remains dormant during the winter; in the spring the whole contents escapes from the membrane, excretes a cell-wall, and developes into a normal swarming cell with two vibratile cilia.

Spore-formation in Yeast.*—Herr A. Zalewski has investigated spore-formation in *Saccharomyces ellipsoideus* Rees, *S. apiculatus*, and *Mycoderma vini*. After the cells have been left twenty-four hours in water, they cease to be very refringent, and become finely granular. The protoplasm collects on the walls, afterwards shrinks up at one point, and gathers on either side of this. It incloses black points which the author regards as developing nuclei. These, however, soon disappear, and the two masses increase rapidly, rounding themselves off and forming a membrane. In *Mycoderma vini* the nuclei are more evident, and the spore-formation again takes place by division of the protoplasm. In the vegetative forms the nuclei can be readily demonstrated by placing the cells in water for some hours, and then treating them with hæmatoxylin and alum solution.

Detection of "wild yeast" in low yeast.†—Herren J. C. Holm and S. V. Poulsen have determined by experiment the minimum quantity of "wild yeast"—giving a bitter taste to the wort without causing fermentation—which can be detected in the "low yeast" of *Saccharomyces cerevisiæ*. The mode of recognition employed was Hansen's, viz. the formation of ascospores; and the authors found that even as small an admixture as 0·5 per cent. could be detected in this way, the "low forms" used being *S. Pastorianus* and *ellipsoideus*. With an admixture of from 1 to 2 per cent. of "wild yeast," ascospores begin to be formed in 30 hours, and are abundant in 40 hours.

Acetous Fermentation.‡—Sig. A. Romegialli states, as the result of a number of experiments, that the growth of the acetous ferment is increased

* Arch. Slav. de Biol., ii. (1886) p. 293, from Ann. Acad. Sci. Cracovie, 1885.

† Medd. Carlsberg Lab., ii. (1886) pp. 147–5. See Bot. Centralbl., xxvii. (1886) p. 231.

‡ Gazzetta, xvi. (1886) pp. 73–101.

by the presence of glycerol and of succinic and malic acids, of which the first is the most readily assimilated; secondly, asparagin is more favourable than albumin, whilst ammonium chloride and phosphate are not convenient media for furnishing the requisite nitrogen. The presence of sulphur, silica, and iron are useful, if not indispensable, to the ferment.

Mycoderma aceti (?) contains 71·3 per cent. of a substance showing all the reactions of cellulose; the remainder consists of albumin, fatty substance, and ash (4·4 per cent.), the last consisting of chlorine, and silicic, sulphuric, phosphoric, and carbonic acids, combined with potash, soda, lime, magnesia, and ferric oxide.

Lactic Fermentation.*—Herr G. Marpmann remarks on the very contradictory views still prevailing as to the nature of lactic fermentation. During the past summer he has investigated the micro-organisms of cows' milk in the neighbourhood of Göttingen, and has detected five seemingly new and different species, which more or less strongly induce lactic fermentation in cane sugar as well as in milk. Coagulated milk filtered, mixed with 10 per cent. of pure gelatin, was employed as a medium for the cultivation of the above.

Fate of Microbes in the Blood of Warm-blooded Animals.†—Experiments by Herr W. Wyssokowitch show that both the spores of fungi (*Aspergillus*, *Penicillium*, &c.) and bacteria disappear very rapidly from the blood of warm-blooded animals. Of saprophytic bacteria injected into the blood of animals, not a trace was visible, after three hours, of *Bacillus subtilis*, *B. acidi lactici*, *Micrococcus aquatilis*, or *Spirillum tyrogenum*. Of those which are pathogenic to man, *Micrococcus tetragonus*, *Bacillus typhi abdominalis*, *Spirillum choleræ asiaticæ*, and *Streptococcus pyogenes*, disappeared in from 3 to 4½ hours. Those which are pathogenic to the animal experimented on of course increase rapidly in numbers till its death.

The microbes which disappear do not pass from the blood into the kidneys or entrails. The author believes that they find their fate chiefly in the endothelial cells. Between these cells and the bacteria there is a constant warfare. Either the former conquer and the bacteria perish, or the cells are themselves destroyed by the bacteria, in which case the microbe is pathogenic for the animal in question.

Influence of Desiccation and Temperature on Comma-Bacilli.‡ — Herr L. Lenevitch finds that desiccation at the ordinary temperature is always fatal to the comma bacilli of Koch. In a fluid medium the effects vary considerably. Thus at 60° C. the vitality is reduced, while at 70° the bacteria are killed in half an hour or an hour. A few minutes' exposure to a temperature of 100° is fatal. The author emphasizes the extreme difficulty of securing desiccation and uniform diffusion of heat. He regards at least 100° C. as effective for the destruction of comma bacilli in a fluid medium.

Bacterium maydis.§—Prof. G. Cuboni believes that "pellagra" is, like cholera, the result of the excessive development of an intestinal *Bacterium*. He has lately investigated the characteristics of this *Bacterium* (*B. maydis*).

1. In gelatin cultures in contact with air, the colony appeared first in the form of minute white spots, which gradually increased, dissolving the

* Arch. Pharm., xxiv. (1886) pp. 243–56. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 733.

† Zeitschr. f. Hygiene, i. (1886) pp. 1–45. See Bot. Centralbl., xxvii. (1886) p. 263.

‡ Arch. Slav. de Biol., ii. (1886) pp. 306–7, from Vratch No. 8, 1886.

§ Atti R. Accad. Lincei—Rend., ii. (1886) pp. 532–5 (2 figs.).

gelatin and forming a compact spherical mass. When not in contact with air, the colony remains as small points, forming a slight opaque turbidity, which increases till it unites and the whole of the gelatin is dissolved internally.

2. In a pure culture, in a tube containing gelatin and maize flour digested with diastase, the colony assumed a funnel-like form, at the foot of which there is always a nucleus of white substance.

3. The form of *Bacterium monas* is not constant. The long bacillar type, 3 μ long by 1 μ broad, segments into much smaller elements, like true bacteria, and resembling grains of rice, which finally divide into still minuter pieces, like micrococci, only more elliptical. The nuclei of spores were observed.

"Foul-brood" of Bees.*—Dr. Ciesielski describes the mode in which this disease is caused by the newly discovered *Bacillus Preussii*. It developes in the intestinal canal of the larva, destroying the entire body by its rapid increase. In each bacillus are formed four spores towards the end of its development, which germinate only within the bee, and develope again into the bacillus.

Intestinal Bacteria.†—Herr T. Escherich proposes to include under the term *Helicobacterium*, all forms characterized by the absence of endogenous spores, the power of swarming, the transformation, under certain conditions, of filamentous, short-rod, and coccus forms, into spiral and zoogloea-forms, the excretion of a ferment which dissolves solid albumen and coagulates the casein of milk, and which occur on animal nutrient substances and in the intestinal canal. The group would include Hauser's *Proteus vulgaris*, Kurth's *Bacterium Zopfii*, and a microbe found by the author in the contents of the intestines.

This organism was met with in the intestinal canal of guinea-pigs, on imperfectly sterilized fibrin, and in the intestines of a dog fed on meat. On a gelatin-plate it appeared as a delicate pellicular colony from which a number of beautifully coiled spirals penetrated the gelatin. On a new plate the surface was, after twenty-four hours, covered with dry scales, while within the gelatin were much-branched and coiled colonies. Under the Microscope, pointed or fusiform zoogloea-colonies were seen to proceed from round yellowish balls, often running out into long beautiful spirals. This peculiar appearance arises in the following way.

From an interior spherical colony springs a delicate, at first only slightly coiled, thread, which becomes coiled from the thread growing more rapidly than its apex penetrates into the gelatin. Dense agglomerations are formed, especially at the parts near the point of exit; and these coalesce into moniliform expansions, and develope into the coiled and fusiform zoogloea-colonies. By the rapid development of these formations the substance of the gelatin becomes covered by a branched system of zoogloea-colonies, connected by countless anastomoses. Between the meshes of this network are numerous groups of swarming bacilli, spirulinæ, and coiled threads. The movement of the bacilli is not so active as that of *Proteus vulgaris*.

The coloured cover-glass preparation shows roundish or elliptical forms grouped in various ways. They are usually combined into diplococci, though also in tetrads, small groups, or chains. The round forms have a diameter of not quite 1 μ; they are stained uniformly and intensely by anilin. The zoogloea-colonies are composed either of large cylindrical bacilli, 0·9 μ broad and 3–10 μ long, or of long parallel filaments, some of

* In Polish, 1884. See Bot. Centralbl., xxvii. (1886) p. 346.

† Munch. Med. Wochenschr., xxxiii. (1886). See Bot. Centralbl., xxvii. (1886) p. 228.

which are of enormous length. After the fourth day the filaments and rods break up into smaller and smaller fragments, resulting in chains of diplococcus-like structures, which finally separate into cocci. In this state, corresponding to the spore-condition of the endosporous forms, they may preserve for a long time their vitality and power of development. Macroscopically, the cultures agree almost entirely with the contagium of syphilis, described by Klebs under the name *Helicomonas syphiliticum*.

Contagium of Lung-disease.*—Messrs. J. Pohls and W. Nolan find, in all cases of fresh lung-disease, a particular micrococcus constantly present in the lungs and in the exudation in the pleural cavity, which can be readily cultivated. It occurs both as coccus and diplococcus, occasionally as triplococcus, or there may be as many as six arranged in a chain. The coccus is nearly or quite spherical, with a diameter of about 0·5 μ, but varying between 1·2 and 1·5 μ. Uncoloured preparations from the lungs and from the pleural exudation showed some invested with an evident envelope like Friedländer's *Pneumococcus*, from which, however, it was distinguished by a higher receptivity for pigment, being coloured by all the aniline-pigments.

From the facts that this coccus is always absent from the lungs of sound cattle; that it is always present after inoculating with lung-disease; that, when cultivated in pure cultures, it can be used for inoculation, causing pulmonary changes in cattle a few days after infection, the authors conclude that it is itself the contagium of lung-disease.

Swine-fever.†—Dr. Löffler describes the microbe which always accompanies this disease, in the form of delicate rods similar to those of Koch's septicæmia of mice, but somewhat shorter and slightly thicker. With Weigert's picrocarmine-gentian-violet double staining they take an intense flesh-tone colour, and are then readily seen in the pink tissue. By Gram's method they are still more easily rendered visible. Cultures in various nutrient fluids produced only the one kind of bacterium, closely resembling that of the septicæmia of mice. In one instance small ovoid bacteria were obtained, and the author concludes that probably two distinct but similar diseases are included in the term "Rothlauf."

Dr. Löffler's results are in essential points confirmed by Dr. Schütz.‡ He finds that, in contrast to pigeons, fowls are not receptive to the virus of the swine-fever. He regards the disease as identical with the French "rouget des porcs."

Swine-fever.§—The description of the microbe of this disease by Drs. A. Lydtin and M. Schottelius agrees in its main features with that of Löffler,‖ except that they speak of the bacilli as somewhat larger and as apparently forming spores. For staining they use Gram's gentian-violet-iodine pigment with secondary staining by a dilute aqueous solution of vesuvin. It is found in all the organs of infected animals, especially the kidneys, liver, spleen, and lymphatic glands, particularly in those of the intestinal canal. In cases of spontaneous disease, the authors noticed in addition a longer, thicker, motionless bacillus, forming rows of spores which have the peculiarity of germinating, not in the direction of the rod, but at right angles to it. They believe, however, that the former is the true

* Fortschr. d. Med., iv. (1886). See Bot. Centralbl., xxvii. (1886) p. 230.

† Arbeit. K. Gesundheitsamte, Berlin, i. (1885) pp. 46–55. See Bot. Centralbl., xxvii. (1886), p. 257.

‡ Ibid., pp. 56–74 (7 pls.). See Bot. Centralbl., xxvii. (1886) p. 324.

§ Lydtin, A., u. Schottelius, M., 'Der Rothlauf d. Schweine.' 254 pp. and 23 pls. Wiesbaden, 1885. See Bot. Centralbl., xxvii. (1886) p. 292.

‖ See *supra*.

bacillus of swine-fever, and they found it fatal to mice, rabbits and pigeons, but not to white or wild rats, dogs, or fowls.

Necessity of Oxygen for Bacteria.*—Dr. P. Liborius publishes the results of a series of experiments on the degree to which various bacteria can carry on their vital functions under partial or entire exclusion of oxygen. Of a variety of methods employed for excluding oxygen, the most efficacious was found to be the replacement of the air by aqueous vapour or by hydrogen; almost as good results were obtained by the superposition of a thickness of 3 cm. of a solid nutrient substance. The nutrient employed was extract of meat peptone-gelatin with 5, 7, or 10 per cent. of gelatin, and 1 per cent. of agar-agar.

Some bacteria were found to be very indifferent to the exclusion of oxygen; these were especially *Bacillus acidi lactici*, *Proteus vulgaris*, *Streptococcus pyogenes*, *Bacillus pneumoniæ*, *B. crassus sputigenus*, *B. prodigiosus*, and *B. murisepticus*. The growth of *Staphylococcus aureus*, *B. typhoidei-abdominalis*, *Spirillum choleræ-asiaticæ*, *S. tyrogenum*, and *S. Finkleri* was also not completely arrested by deprivation of oxygen. Other species showed under these circumstances a change in their biological properties, a loss of some characteristics, or an arrest of growth. But the degree of deprivation of oxygen necessary for these changes varies with the different species.

The property first affected is the production of pigment, for which contact with free oxygen is necessary. It follows that the bacteria can produce only a chromogenous substance which is converted into a pigment by oxidation. The power of peptonizing is also soon affected; but this varies, even when the supply of oxygen is abundant, according as the nutrient substance contains sugar or not. With the cholera-spirillum deliquescence is prevented by the entire elimination of oxygen; while with *Bacillus prodigiosus* and *Proteus vulgaris* it is only retarded under these circumstances. The fermenting power of bacteria also depends largely on the composition of the nutrient substance. *Bacillus aerophilus* appears to be the species most dependent for its development on the presence of oxygen.

A number of anaerobes were isolated by cultivation on solid substrata, and the following specially described:—1. *Bacillus œdematis-maligni;* bacilli 3 μ long, 1 μ broad, often growing into long threads; spores not in threads, but in single fusiform bacilli. 2. *Clostridium fœtidum;* bacilli 1 μ broad, varying in length, actively motile, often in pseudo-filaments; spores usually in the middle of the swollen filament, but also towards the ends, oval, strongly refractive. 3. *Bacillus polypiformis;* bacilli slender, more than 1 μ broad, varying in length, with no tendency to the formation of threads; spores oval or cylindrical, often occupying one-half to one-third of the filament. 4. *B. muscoides;* bacilli slowly motile, with slight tendency to the formation of threads; spores roundish oval, mostly terminal, strongly refractive. 5. The pseudo-œdem bacilli; found in company with the œdem-bacilli, thicker than they, surrounded by a light border, usually with two spores in each bacillus. They are pathogenic, apparently in consequence of the formation of a ptomaine.

Bacteria in Drinking-water.†—Herr M. Bolton finds that certain bacteria exist in ordinary spring water, and are capable of multiplication in it. Among these two may be specially mentioned: *Micrococcus aquatilis*, which occurs as cocci collected into small irregular heaps, and *Bacillus*

* Zeitschr. f. Hygiene, i. (1886) pp. 115–77 (2 pls.). See Bot. Centralbl., xxvii. (1886) p. 198.

† Zeitschr. f. Hygiene, i. (1886) pp. 76–114. [See Bot. Centralbl., xxviii. (1886) p. 16.

erythrosporus, distinguished by its spores having a reddish sheen, and the production of a greenish pigment without any deliquescence of the gelatin in which it was cultivated. Both these bacteria multiply to an enormous extent in water, the quality of the water and the amount of organic and inorganic substances contained in it appearing to have no effect on the reproduction, which is, however, materially promoted by an increase of temperature. These bacteria were found in most examples of spring water, and appear to originate chiefly from the surface of the neighbouring soil. These bacteria are not pathogenic.

The author found, on the other hand, that pathogenic bacteria, when introduced into spring water, never multiply, but disappear after a time, varying in length according to the species and the temperature. He concludes that the quantity of bacteria present in spring water is no guide whatever for the wholesomeness or otherwise of the water for drinking purposes, since these are mostly entirely harmless; and that it is impossible, by chemical analysis, to determine the presence of bacteria in larger or smaller numbers.

Chemical Composition of Bacillus anthracis.*—Dr. M. Nencki states that analysis of pure spore-material of *B. anthracis* gives only traces of mycoprotein, the principal ingredient being a proteinaceous substance nearly allied to mucine, soluble only in alkalies, which he calls mycomucine. The pathogenic properties of the bacillus are not due to the prepresence of a poisonous alkaloid, but to its direct action in destroying the living protoplasm of the cell.

Distribution of Micro-organisms in Air.†—The experiments undertaken by Dr. P. F. Frankland were conducted by means of Hesse's method of solid culture media. The apparatus employed consisted of (*a*) a tube, lined by Koch's gelatin peptone, through which a known volume of air could be drawn, and of (*b*) circular dishes containing the same substance, and employed to ascertain the number of micro-organisms falling on a given surface during a definite time. The apparatus is described and figured.

Experiments were made on the roof of the Science Schools, South Kensington; on St. Paul's Cathedral; in rooms, railway carriages, &c., and in the country.

Tables are given showing the place, conditions, number of organisms per volume of 10 litres of air, and number falling on a square foot per minute. From these it is found that in cold weather the number of organisms in the air is very much smaller than during summer, even after rain. Thus, at the top of the Science Schools, with snow on the ground, there were only 4 per 10 litres of air; on a cold, windy day, 433 per square foot fell in a minute. After exceedingly heavy rain, 40 per 10 litres were found to be present in the air. The average of these experiments show 35 per 10 litres, or 279 per square foot.

Of the experiments in the country the average showed 14 per 10 litres and 79 on a square foot per minute. The air in gardens was found to be higher than in the surrounding country.

Of the experiments in Hyde Park, &c., the number of micro-organisms is intermediate between the above two situations; on an average there were 24 per 10 litres of air, and 85 fell on one square foot per minute.

From the experiments made at different altitudes on Norwich Cathedral and St. Paul's, the author finds that the number of micro-organisms decreases

* In Polish, 1884. See Bot. Centralbl., xxvii. (1886) p. 347.

† Proc. Roy. Soc., xl. (1886) pp. 509–26 (3 figs.).

with the altitude. Thus, on the Golden Gallery, St. Paul's, on the Stone Gallery, and in the churchyard, the numbers respectively were, on one occasion, 11, 24, 70 per 10 litres of air. The average at the base of St. Paul's is greater than the average for the South Kensington experiments. The average at the top closely approaches, but is less than the average in the country. In inclosed spaces the number of suspended organisms is very moderate, so long as there is no aerial commotion, but as soon as the air is disturbed the number rises rapidly; as is already known. Thus in a quiet room, 44 micro-organisms fell on one square foot per minute, but with 20 people dancing this number was increased to 400.

In a railway carriage with ten passengers, as many as 3120 fell on a square foot per minute.

Multiplication of Micro-organisms.*—Dr. P. F. Frankland gives the results of his experiments on the multiplication of micro-organisms found in the unfiltered waters of the Thames and Lea, in the filtered water derived from these sources, as supplied by the water companies of London, and in water from deep wells. The author used Koch's method of plate cultivation with peptone gelatin. The apparatus is described in a previous paper,† but distilled water is substituted for mercuric chloride in the moist chamber.

He finds that all these waters contain abundant micro-organisms, the number of which, however, varies considerably. The crude water of the Thames and Lea usually contains thousands per cubic centimetre, whilst in deep well water the number is reduced to 10.

Tables are given showing the multiplication under various conditions, e. g. frost, daylight at 20° C., darkness at the same temperature, &c., during various lengths of time. There is a tendency for the number of micro-organisms to be reduced in number if kept at 20° C., whereas an incubating temperature of 35° C. causes a rapid increase. The number found in filtered water is only about 5 per cent. of that in the unfiltered river water. The micro-organisms in filtered water left standing for 24 hours, even in cold weather, undergo a slight increase in number, which is greatly increased if they are kept in a refrigerator for a longer period. It seems that the organisms in this water multiply at 20° C. at a much greater rate than those in unfiltered water.

In the case of deep well waters, the organisms have little tendency to multiply in the cold; but at 20° C. far exceeds that in the other waters.

The author infers from this rapid multiplication, and from the fact that at the outset the well water is nearly free from micro-organisms, that the little nutriment necessary for the purpose has been wholly untouched; whilst in river waters it has been attacked by numerous generations of micro-organisms. The number of different varieties is much greater in the latter case than in the former, so that in these well waters the micro-organisms have little or no competition.

The second part of the paper deals with pathogenic organisms, more especially with their multiplication when purposely introduced into the various waters. The three forms studied are *Bacillus pyocyaneus*, Finkler-Prior's *Comma spirillum*, and Koch's *Comma spirillum;* and the nature of the growth in the cultivating medium is described.

The author draws attention to the fallacy of the conclusions drawn as to the vitality of pathogenic bacteria in general. Each individual organism must be made the subject of separate investigation. Any initial weakness

* Proc. Roy. Soc., xl. (1886) pp. 527-44 (3 figs.).
† See this Journal, 1885, p. 923.

of growth renders it less capable of withstanding the conditions of experiment. Hence the discrepant results of various observers on antiseptic action.

Reduction of Nitrates by Micro-organisms.*—MM. U. Gayon and G. Dupetit contribute a biological study of certain denitrifying microbes by the method of cultures, an examination of the products and mechanism of the chemical reactions which they provoke, and a discussion of the agricultural application of the phenomena.

The reduction of nitrates to nitrites is brought about by many different microbes; but this memoir is devoted especially to an account of two which, in the presence of organic matter, decompose nitrates with production of nitrogen and nitrous oxide. These two microbes were obtained by the authors from sewage; and they have isolated and studied them by systematic cultures in sterilized liquids under various conditions.

Bacterium denitrificans α, the more active of the two, is 0·4 to 0·6 μ broad by 2–4 μ long, of feeble refraction, and outlines not clearly visible except in stained preparations. They are in very active motion in liquids containing nitrates, and multiply by fissiparity during the first days of development; afterwards 1–3 spores form in each individual. *B. denitrificans β* differs little under the Microscope from the preceding; it is a little larger and more refractive. These two bacteria are best distinguished by the rate of their development and by the products of their action on nitrates under comparative cultures in the same medium. They are best stained by methyl-violet and by gentianin. A sterilized liquid sown with *B. denitrificans α* evolved gas after eighteen hours. By exact analyses of the evolved gases, and of the fermented liquids, the authors show that the whole of the nitrogen of the nitrate is evolved as gas, and that the whole of the oxygen of the nitric acid is combined with the carbon of the organic matter to form carbonic anhydride. Organic matter is essential to the reaction; 1 gram of nitre requires 0·148 gram of carbon or 0·273 gram of albuminoid matter for its complete decomposition. Denitrification is accompanied by a very considerable rise of temperature—in meat infusions 5°·45, and in the artificial medium 10°. The destruction of nitrates by soil observed in Schloesing's experiments is explained by the authors as the work of bacteria similar to those with which they experimented.

Hüppe's Bacteria.†—In this important work the different forms of Schizomycetes, their development, and their relationship to one another, are treated of in great detail. The same species may occur under three different forms, which are, of course, not sharply differentiated from one another, viz. (1) The coccus form, including all isodiametric, spherical, or only slightly elongated ellipsoidal cells; (2) the rod-form, with distinct elongation in one direction; and (3) the spiral form, spiral rods, which can, however, on superficial observation, be readily seen to be curved rods. He regards the presence of true protoplasmic vibratile cilia as no essential condition for spontaneous movement; the structures hitherto described under this name probably vary in morphological and physiological value.

As a classification of "genera" and species of Schizomycetes, Dr. Hüppe proposes the following:—A. Bacteria with formation of endogenous spores: 1st genus, Coccaceæ, with subgenera Streptococcus (?) and Leuconostoc(?); 2nd genus, Bacteriaceæ, with subgenera Bacillus and Clostridium; 3rd

* Station Agron. de Bordeaux, Nancy, 1886. See Journ. Chem. Soc. Lond.—Abstr., 1. (1886) p. 823.

† Hüppe, F., 'Die Formen d. Bakterien u. ihre Beziehungen zu d. Gattungen u. Arten,' 152 pp. and 24 figs., 8vo, Wiesbaden, 1886.

genus, Spirobacteriaceæ, with subgenera Vibrio and Spirillum. B. Bacteria with formation of arthro-spores (including those the mode of fructification of which is not yet known): 1st genus, Arthro-coccaceæ, with subgenera Arthro-streptococcus, Leuconostoc, Merista, Sarcina, Micrococcus, and Ascococcus; 2nd genus, Arthro-bacteriaceæ, with subgenera Arthro-bacterium and Spirulina; 3rd genus, Arthro-spirobacteriaceæ, with subgenus Spirochæte; 4th genus, Leptothricheæ, with subgenera Leptothrix, Crenothrix, and Phragmidiothrix (?); 5th genus, Cladothricheæ, with subgenus Cladothrix.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Bulloch's Student's Microscope.—In this instrument, by Mr. W. H. Bulloch, of Chicago (fig. 1), the stage is connected with the stem by means

FIG. 1.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Manipulation; (7) Microscopical Optics, Books, and Miscellaneous matters.

of a strong angle-piece, leaving space for the free movement of the radial swinging tail-piece. The arrangement is a modification of the plan adopted some time ago by Mr. Bulloch, to remedy the flexure so commonly found in the Zentmayer mechanism, where the stage is carried by a conical spindle passing through a sheath in the lower end of the stem, the swinging tail-piece fitting by means of a collar outside the sheath.

Bausch & Lomb Optical Co.'s Combined Inverted and Vertical Microscopes ("Laboratory" and "University" Microscopes).—The Inverted Microscope, in the forms issued by M. Nachet, is well known to microscopists. The Bausch & Lomb Optical Co. have now combined it with the ordinary vertical form, the principle involved being, they believe, entirely new. "There is no question that the fact that the inverted could only be used as such, and that it was but incomplete at the best, has precluded its more general use, and we have no doubt that offering them as we do now by combining two instruments in one, and supplying each with such complete adjustments as modern requirements demand, they will be found to fill a necessity in certain branches and prove a great convenience in others. . . . This form of instrument is particularly adapted for chemical investigations, for the reason that crystals may be studied as they lie in their natural position in any depth of fluid, and the head is sufficiently distant from the stage not to inhale any fumes. Further than this, it is valuable in the examination of diatomaceæ and other objects in water which are heavier than it, and therefore sink to the bottom; also in moist histological preparations, as they adhere to the surface of the slide, and are therefore in one plane. It is also an excellent dissecting Microscope, as it is partially erecting, offers no hindrance to manipulation with any power, and makes it convenient to observe the object directly." *

There are two forms, the "Laboratory" and the "University."

The "Laboratory" Microscope when used as an inverted instrument, is shown in fig. 2. The mirror-bar swings on an axis in the plane of the stage to any point above or below it. The mirror and substage are adjustable on the mirror-bar. The substage carries a revolving diaphragm, and is fixed on a pivot so that it will swing in and out of the optic axis, allowing the polarizer to be attached and ready for instant use. On the slide is the arm, to the lower side of which is fastened the prism-box. On the upper horizontal surface of this is the nose-piece, with an extra adapter for high powers, and in the oblique surface is a screw-socket for the body-tube.

To transform the instrument into an ordinary Microscope, fig. 3, the tube is unscrewed, the milled head at the front of the arm loosened, which releases the prism-box, and the arm is swung on its axis from between the pillars into an upright position. The tube is now attached to the opposite side of the nose-piece, and after the stage clips are reversed it is ready for work.

The "University" Microscope (figs. 4 and 5) is in its general construction similar to the preceding, except that the (single) pillar and the arm are not japanned but are of brass, and that the instrument swings on an axis which is the same as that of the mirror-bar. The stage consists of a glass plate mounted in a brass ring.

The prism used for inversion is that suggested by Mr. J. Lawrence Smith

* 'Illustrated Catalogue of Microscopes, Objectives, and Accessories,' 10th ed., 1886, p. 33.

FIG. 2.

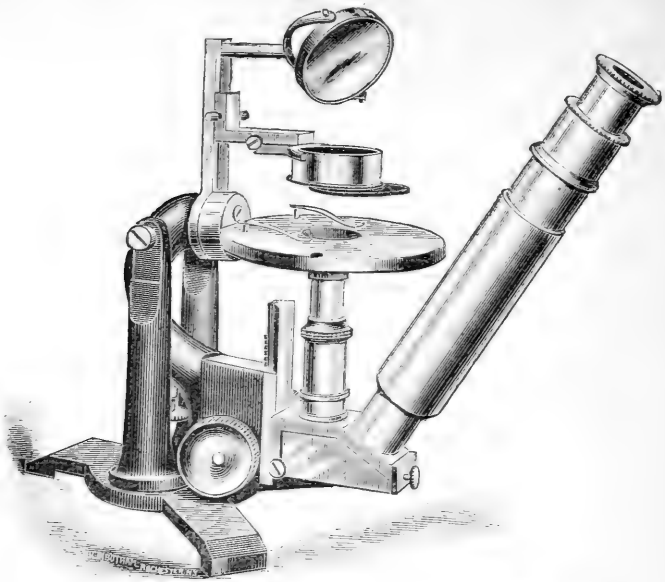


FIG. 3.

FIG. 4.

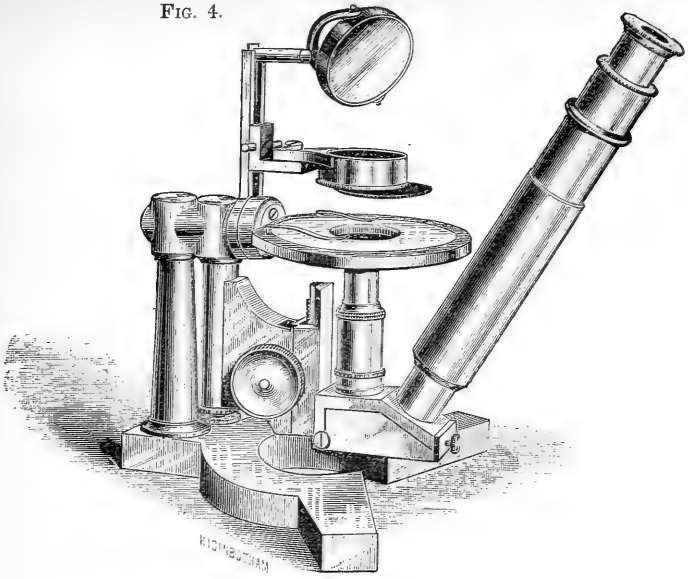
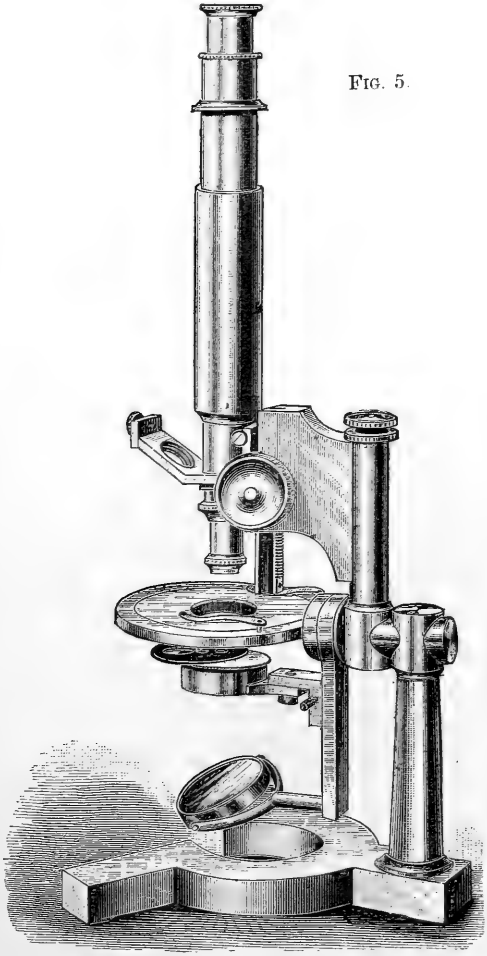


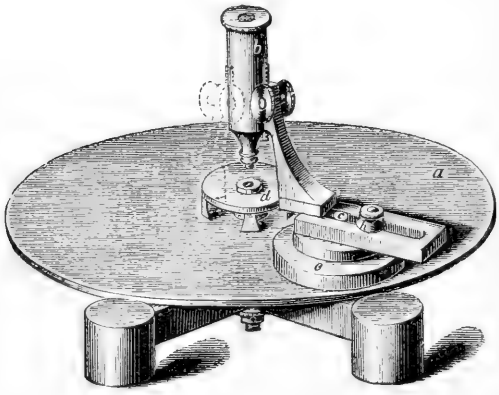
FIG. 5.



in 1851, having four faces, with angles of 57°, 150°, 48°, and 105°, the rays being twice totally reflected.

Berger's Microscope for fixing Spider's Threads.*—Mr. C. L. Berger describes the following Microscope for the adjustment of distance-threads in telescopes for theodolites, &c. To fix the threads in the grooves is used a small apparatus *b* (fig. 6), which stands upon a rotating plate *a*; *b* can be both rotated about the pin *c*, and moved backwards and forwards, and

Fig. 6.



clamped by the screw *h*. The apparatus can also be moved with the stand *e* to different parts of the plate, so that the diaphragm (for the telescope) need not be moved. The latter is held by a spring on the little stage *d* in the centre of the table *a*, and there is a mirror under *d*. With this apparatus he has been able to adjust the distance-threads for use with normal levelling staffs to within 0·001 of their true position, which corresponds to an error of 0·1 foot at a distance of 100 feet. This error, especially with long distances, lies within the limits of the accuracy which can be attained with distance-threads in general, and may in most cases be neglected. By using a micrometer-screw with the Microscope, as is done with dividing machines, the threads may be still more accurately adjusted before they are fixed to the diaphragm, and the error still further reduced.

Koch's Microscope for determining Coefficients of Elasticity.†—The apparatus originally devised by Dr. K. R. Koch for his experiments on the elasticity of crystals, is now made in an improved form by Breithaupt and Son, of Kassel, and is shown one-fourth natural size in fig. 7.

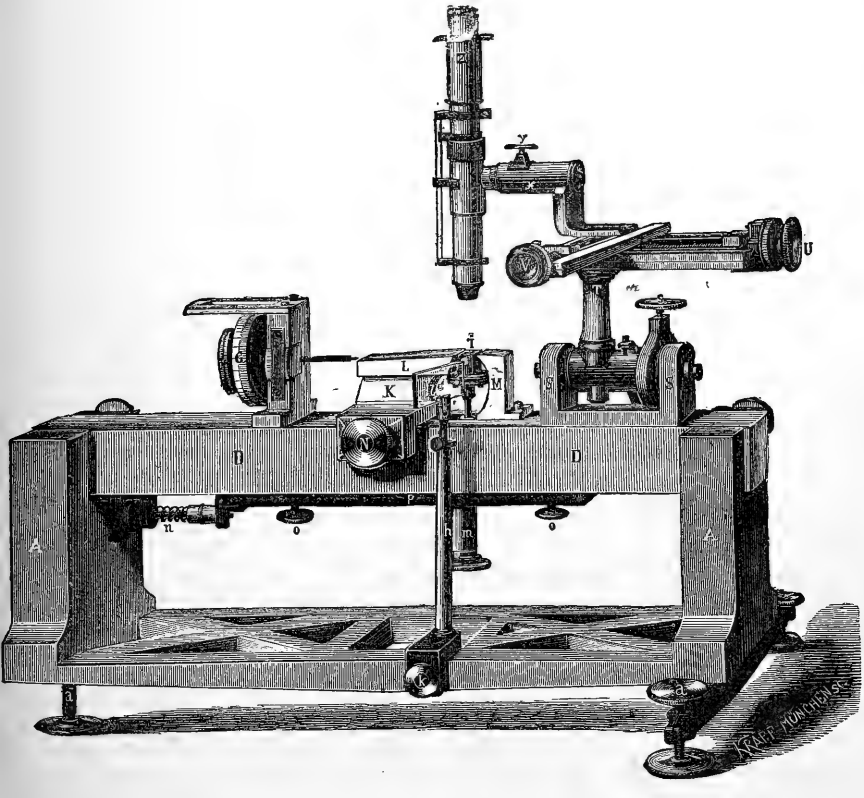
A solid stand A, of lacquered iron, supported on three levelling screws *a*, carries the steel bar D on which is fixed the steel anvil M; the upper surfaces of M and of a similar anvil L are slightly bevelled upwards, so that the plate or bar to be examined, when placed upon M and L, rests upon their inner edges alone as two linear supports; L is, however, not fixed, but is suspended on a knife-edge forming part of K, parallel to the length

* Zeitschr. f. Instrumentenk., vi. (1886) p. 276 (1 fig.).

† Groth, P., 'Physikalische Krystallographie,' 2nd ed., 1885, pp. 660–6, 3 figs.

of D, so that when the plate is in position, and loaded with a weight, L adjusts itself to parallelism with M, and the plate rests evenly upon the two edges. The block K which carries L is not fixed, but is made to slide along the bar D, and is clamped by the screw N; in this way the distance between the inner edges of L and M can be set to any length between 10 and 30 mm. Between L and M and beneath them is a totally reflecting prism *i*, by which the light reflected into it by the glass plate on the rod *h* passes vertically upwards through the upper horizontal face. The prism is fixed on three screws, by which its upper surface may be adjusted to

FIG. 7.



parallelism with the plate, and it is slowly raised or lowered by a milled head at the lower end of *m*. The prism is supported on the plate *p*, and can always be brought into the middle of the space between L and M by the screw *n*, and fixed by the clamps *o o*. The position of L, and consequently the distance between L M, may be measured either by the micrometer-screw and index at G, or more conveniently by the Microscope *z*. S is a horseshoe support, in which turns an axle bearing the pillar T and clamped by *s*. Upon T are the two slides with micrometer-screws U V, by which the Microscope *z* can be moved horizontally through measured distances, either parallel or perpendicular to the length of the bench; *z* turns about the axle *x*, which is clamped by the screw *y*. The Microscope itself

is of small magnifying power, and is roughly focused by raising or depressing the tube, while by turning a grooved ring in the middle of the tube a fine-adjustment is obtained; there is a fixed and a movable thread with graduated circle.

In using the instrument, the Microscope, fixed in the vertical position by a stop on the axle S S which abuts on D, is first adjusted to the inner edges of L and M successively by means of the micrometer-screw V; (U and V have drums divided into 100 parts each, equivalent to a motion of 0·005 mm.); this determines the distance between the edges and the position of the experimental plate upon them. The screw *s* is then loosened and the Microscope is rotated about the axle S S into the horizontal position, where it is held by a second stop and counterbalanced by a weight fixed on the lower end of T. It is then focused upon the upper surface of the prism which is slightly curved; the prism is raised until it just touches the plate with its central point, and the interference rings are seen in the field of view, when monochromatic light is reflected into the prism. If a small space intervenes between the plate and the prism, then when the plate is loaded this space is diminished and the interference rings travel across the microscopic field, a motion through the breadth of one ring being equivalent to a vertical displacement of half a wave-length; in this way the extent to which the plate is bent may be measured in fractions of a wave-length.

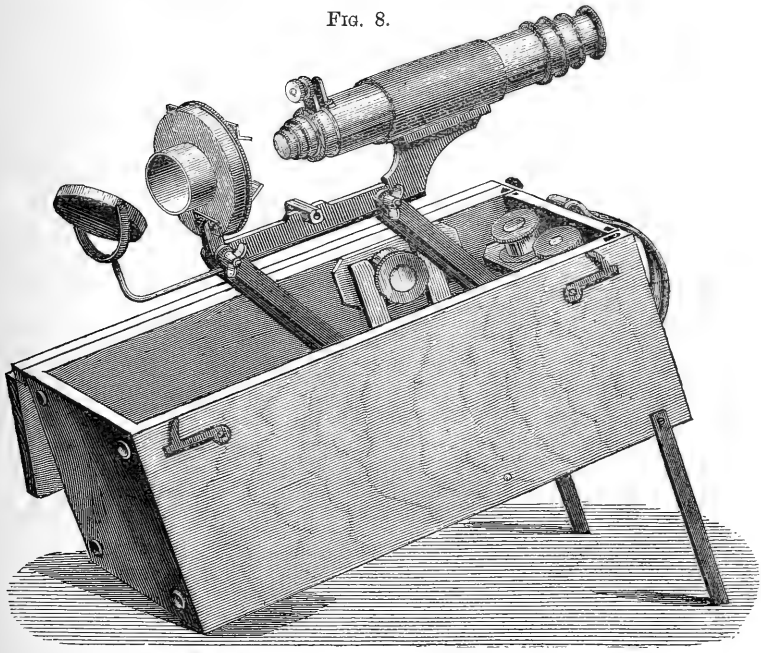
The apparatus above described constitutes a complete micrometer for the measurement of lengths and angles within the space of 4 sq. cm. covered by the motions of the screws U and V, and may therefore be applied to microscopical measurements for a variety of purposes. In this case the object to be measured is placed upon an object stage, which rests upon D above K and M, and is provided with a rotating glass plate mounted in brass, and illuminated either with a lens from above, or from below with the prism or a small mirror. In this form the instrument is especially applicable to the measurement of Senarmont's or Röntgen's ellipse of heat-conductibility, and to the examination of etched figures upon crystal faces; for the latter purpose it is particularly convenient when it is required to measure the angle between the edge of an etched figure and an edge of the crystal which is at some distance from the same, that is to say, when the crystal is so large that a well-defined etched figure and the outline of the crystal face are not visible together in the Microscope; in such a case the movable thread is adjusted to the edge of the etched figure; the Microscope is then shifted by means of the screws U V until the edge of the crystal appears, when its direction may be determined by the movable thread.

Moginie's Travelling Microscope.—This (fig. 8) was designed by the late Mr. W. Moginie, in order to provide an instrument which could be very rapidly set up when travelling, and without the necessity of separating it from its case.

The limb supporting the socket for the body-tube and the stage is attached by thumbscrews to the upper ends of two pairs of parallel bars, the lower ends of which turn on pivots fixed to the bottom of the box. When the bars are depressed the limb, with the body-tube, stage, and mirror, drops into the box. The loss of time in the operation of taking a Microscope out of its box and replacing it again is thus avoided.

At one end of the box are two flat rods or feet, turning on pivots and allowing the box to be inclined, as shown in the fig. On the bottom are two similar feet which also turn on pivots, so as to extend horizontally on

Fig. 8.



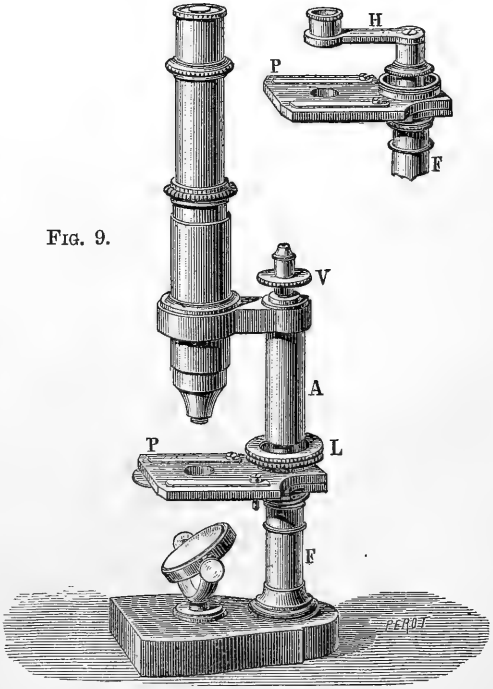
either side of the end of the box, increasing its stability when the Microscope is used in a horizontal position.

The box contains eye-pieces, cameras, animalcule-boxes, and other accessories.

Nachet's Compound and Single Dissecting Microscope.—In this instrument (fig. 9) M. Nachet has applied the arrangement of his Travelling Microscope for readily converting it from a compound to a single Microscope. This is accomplished by unscrewing the milled ring L at the base of the pillar V A, when the latter, with the body-tube, can be removed from the lower part of the instrument P F, and an arm H, carrying dissecting lenses, substituted.

Though the conversion is rapidly effected, the connection does not appear to be in any way wanting in solidity.*

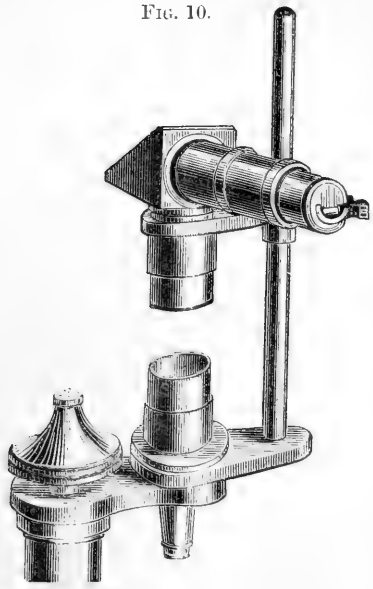
Fig. 9.



* A similar arrangement was adopted in the Nachet Travelling Microscope.

Pfeifer's Embryograph.*—This piece of apparatus, the work of Mr. A. Pfeifer, the instrument-maker of the Biological Laboratory of the Johns-Hopkins University, Baltimore, "renders the Zeiss-Oberhauser camera available for drawing objects under very low magnifying powers." It consists, first, of a collar fitted to the arm of the Microscope, and furnished with a short draw-tube, which can be placed with the objective either above or below the arm; and, second, of a vertical rod, supported on an arm which is clamped under the collar of the draw-tube, and carries a second movable arm resting in a collar to support the camera. This arm is held in place by a thumb-screw, and it may be set at any point on the vertical rod. When the Zeiss *aa* objective is used, and the camera is lowered as much as possible, an image magnified about three diameters is projected on the paper, and any amplification greater than three diameters may be obtained by varying the height of the camera, and by the use of the higher objectives.

Fig. 10.



Schott's Microscopes.—A matter that has long puzzled microscopists has happily found a solution, and although the discovery is not calculated to produce any revolution in microscopy, it is worthy of being recorded in a microscopical journal.

Gaspar Schott, in his 'Magia Universalis,'† figures and describes among others the Microscopes shown in figs. 11, 12, and 13. These Microscopes, as will be seen, are apparently of an exceptional and extraordinary size, and no explanation is furnished by the text or otherwise of the advantages supposed to be obtained by their large dimensions. So far as anything is known of the ideas of Schott's contemporaries, there is nothing that in any way tends to show that the uselessness of mere size was not thoroughly appreciated, so far as Microscopes at any rate, in contradistinction to telescopes, are concerned. Added to this, Schott himself writes of gold and silver dust, small seeds, &c., being viewed by these Microscopes, objects which are obviously unsuited for large instruments. As no reasonable explanation was forthcoming, some microscopists fell back upon the notion that Schott was drawing upon his imagination for the whole thing, and that no such Microscopes had ever in fact been made.

We recently received from Prof. Abbe, Traber's 'Nervus Opticus,'‡ and we happened to open it at the plate containing the three drawings

* Stud. Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 480–1 (1 fig.).

† G. Schott, 'Magia Universalis naturæ et artis. I. Magia Optica.' 4to, Herbipolis, 1657, pp. 533–6, pl. xxv. figs. 5, 7, and 8.

‡ P. Traber, 'Nervus Opticus sive Tractatus Theoricus, in tres libros Opticam, Catoptricam Dioptricam distributus,' xxii. and 226 pp. and 35 pls., fol., Viennæ Austriæ, 1690.

which are reproduced in figs. 14, 15, and 16.* It seems to us that these drawings at once furnish an explanation of the difficulty. It will be seen

Fig. 11.

Fig. 12.

Fig. 13.

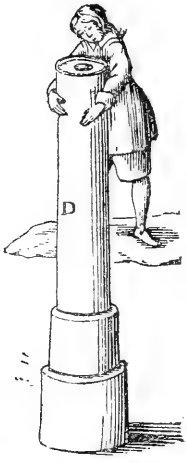


Fig. 14.

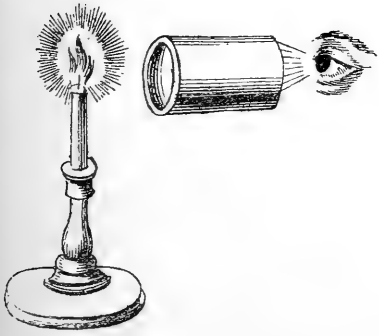
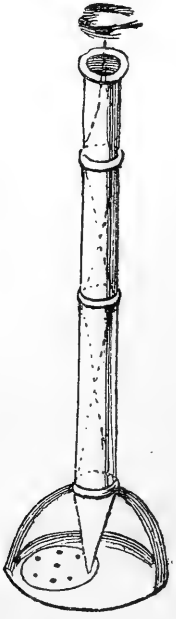


Fig. 15.

Fig. 16.



that in place of a full length of a man being drawn as the observer at each instrument, *an eye* only is given. The change that this makes requires no enforcing. The whole scale is at once altered, and the Microscopes are reduced from their apparent size of 4 or 5 feet to scarcely as many inches. Schott's draughtsman was probably of an artistic turn of mind, and added the full-length figures with the view of enlivening and illuminating what he probably felt to be very inartistic pictures. That he succeeded in making much prettier pictures may be freely admitted, but he little thought to what erroneous deductions his artistic tastes would give rise.

We are not overlooking the fact that Traber's book was not published

* Tom. cit., pp. 66–8, Lib. i. Tab. iv.

until 1690, while Schott wrote in 1657, but this cannot militate against the striking evidence furnished by the three figures. Traber, who lived at Vienna, may well have heard from Schott or otherwise of the mistake that had been made in the drawings, and corrected it accordingly.

Schiefferdecker's Fine-Adjustment Screw.*—Dr. P. Schiefferdecker describes a micrometer-screw made by Winkel of Göttingen, which is so constructed, that lateral movement is altogether prevented, and the action of the screw is very regular and easy.

Fig. 17 shows a section of the apparatus viewed from behind. The casing which carries the tube is fixed by means of an arm to a hollow trilateral

FIG. 17.

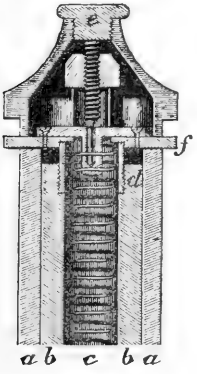
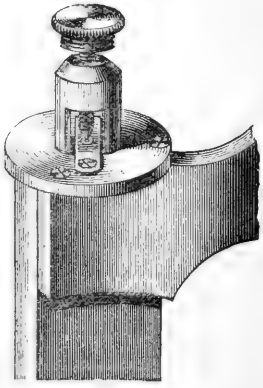


FIG. 18.



"prism" *a*. The sides, i. e. the right and left surfaces of the latter, are with the arm made of one piece; the base, i. e. the hinder surface, is screwed on to the adjacent sides. In *a* is a second trilateral prism *b*, the lower end of which is screwed to the foot of the Microscope. This prism is fitted most accurately into the cavity of the former, so that a relatively large friction resistance exists when the two prisms work against each other. The prism *b* has a cylindrical cavity *c*, beginning at the top and going down a definite distance. Its axis coincides with that of the prisms. It contains a strong spiral spring, the diameter of which coincides with that of the cavity. To the upper end of *c* is screwed a hollow steel tube *d*, the internal diameter of which is equal to that of *c*. It projects above *b*, and enters the circular opening of the brass plate *f*, which lies above *a* and closes it. The steel tube *d* is not uniform throughout its extent. After that portion, about 6 mm., which is immediately above *b*, there follows a part of 11 mm. in length, from which the right and left fourths of its wall have been cut away. On this follows a solid end-piece perforated by the micrometer-screw *e*. Through the openings in *d* passes a small brass plate or bridge *g*, which is fixed at each end to the plate *f* by a screw.

If fig. 17 be compared with fig. 18, the position of this bridge will be understood. The spiral spring presses strongly against the bridge which is firmly united to the plate *f*; this, again, is firmly fixed to *a*, which carries the tube. The spiral spring therefore exerts its pressure on the upper end of *a*, pushes on this and the tube, and presses the bridge firmly against the upper solid part of *d*. The micrometer-screw opposes the tension of the spiral spring. It presses on the bridge, not however directly, but by means

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 1–5 (2 figs.).

of a special arrangement. In the middle of the bridge is screwed a short steel cylinder, which extends into the central hollow of the spring for about 8 mm. It possesses a cylindrical cavity, the longitudinal axis of which coincides with that of the cylinder, and which ends conically. Within the cavity is placed a small steel rod, the diameter of which is somewhat smaller, so that the space is not quite filled. This rests with its lower conical extremity in the conical end just alluded to. To the upper squared off end of the rod, which is flush with the upper surface of the bridge, is fixed a small cap in which the point of the micrometer-screw is adjusted. The cap (fig. 17) is intended to protect the parts inclosed from dust, and also to give a firmer hold to the finger.

The following is the action of this contrivance. The cylinder which extends from beneath the bridge to the central cavity gives a firm hold to the spring. The rod in the steel cylinder forms the direct continuation of the micrometer-screw with the advantage of a movable point, and as the rod is of less diameter than the cavity in which it lies, the screw at its lower end is practically movable on all sides. The arrangement offers the following advantage:—If the point of a micrometer-screw is not quite accurately placed, either in consequence of imperfect work, or from warping in hardening, the screw will exert not only a vertical but also a lateral pressure. This will in turn produce a lateral displacement of the tube. If, however, the screw works on an easily movable point which is firmly united to it, and has only a slight lateral movement, vertical motion only will be communicated. Another advantage is, that the friction of the micrometer-screw is as small as possible, and therefore a very strong spring can be inserted without the screw losing its easy regular action. In consequence also of the power of the spring, the prisms *a* and *b* can be fitted so close as to create a relatively strong degree of friction.

(2) Eye-pieces and Objectives.

Finding the general character of the Components of a Cemented Combination Lens.*—Mr. E. M. Nelson premising that it is very useful to know whether a combination consists of two or three lenses, and if those are biconvex, plano-convex, meniscus, &c., gives directions for obtaining such information without uncementing. The method employed is simply the consideration of the reflected images from the surfaces of the glass.

"Take the plane mirror of your Microscope in your hand, and examine the reflection of a window. Notice that it is an erect image, and that when you move the mirror in a certain way the image appears to come towards you. Now look at the concave side, the image is inverted, and when the mirror is moved in the same direction as before the image goes away from you. A convex mirror behaves as a plane mirror, there being only this difference—that the greater the convexity the smaller is the image, which difference is also true of a concave mirror—viz. the greater the concavity the smaller the image. If you now examine a single biconvex lens, you will see a large erect image from the surface next the window, and a small inverted image from the surface on the other side. It acts precisely as if it were a convex and a concave mirror. In a single biconcave lens you have a large inverted and a small erect image. In a plano-convex, with the convex side towards the window, you will find a small erect image from the convex side, and a large inverted image from the plane side. With the plane side towards the window, you will have a large erect image from the plane side, and a small inverted one from the other side. With

* Engl. Mech., xliv. (1886) pp. 320–1 (3 figs.). Journ. Quek. Micr. Club. iii. (1887) pp. 13–7.

the concave side of a plano-concave towards the window, the concave side will give an inverted image, and the plane side an erect image; but with the plane side to the window, you will get two erect images. Converging and diverging menisci have for their convex sides two erect images, and for their concave sides two inverted. I find, however, that in a converging meniscus, if the concave surface is of very large radius, the reflection from it when viewed from the convex side will be inverted instead of erect; in other words, it will take the form of a plano-convex. I imagine that in a diverging meniscus, which closely approximates the form of a plano-concave, the same result would be found—viz. that the image from the flat side, when seen through the more concave side, would be erect instead of inverted, as one would expect; but of this I have no practical experience, not having a single lens of that form to experiment on.

"Now, if we take a cemented doublet, consisting of a biconvex and a plano-concave, we shall very easily see the two bright reflections from the two exterior surfaces—viz. the plane and the convex. The image from the cemented surfaces, however, will not be so readily apparent. With a little attention it will be discovered as a faint image, with most probably a bluish tinge, though occasionally it may have a reddish tinge. When once seen, it will be easily recognized again. A triple combination will have two faint images as well as two bright ones. I find the following the best method of procedure. First find out by the number of faint reflections if the lens is a doublet or a triplet. Next find out the nature of the external surfaces, and write them down—e. g. plano-convex doublet. This means that the combination is composed of two lenses, and that one of the external surfaces is convex and the other plane. Now write down the reflections as they come, beginning at the side next the window, underlining the reflection from the first surface, and putting the reflection from the cemented surface in (). In writing these down, I use the following abbreviations: *e* for erect, *i* for inverted, *s* for small, *l* for large, and L for very large. It is a good plan to draw the lens by representing, first, the external surfaces only, and then filling in the cemented surfaces, according to the reflections you obtain. It is absolutely necessary that the reflections from both sides of the combinations should be ascertained, as it is impossible to discover the construction of the combination from one set of reflections. When the images are large it is as well to look at the reflection of the bar across a window; the knob of the hasp showing if the image is erect or inverted. The images from small lenses require to be examined by a magnifying glass. One word of caution, and that is, until one is practised in picking up these faint images, the very large faint ones are apt to be overlooked. Until one is familiar with the manner of holding a lens, only a faint blue tinge will be seen over the glass; but after a little practice, a distinct image of the window bar will be obtained."

Some examples with figs. are given.

(3) Illuminating Apparatus.

Ahrens's Polarizing Prism.*—Dr. H. Schröder suggests that this prism† may be improved by using linseed oil for cementing instead of Canada balsam, since the surfaces may then be cut at a more convenient angle. This cement is not very tenacious, so that during the cutting and polishing of the prism the parts must be provisionally fastened with Canada balsam, which is finally removed and replaced by the linseed oil varnish.

* Zeitschr. f. Instrumentenk., vi. (1886) pp. 310–1 (1 fig.).

† See this Journal, 1886, p. 397.

(4) Other Accessories.

Super-stage for the Selection and Arrangement of Diatoms.*—Herr E. Debes's instrument (figs. 19, 20, and 21) for selecting and arranging diatoms consists of a ring A fixed to the stage of a large Zeiss dissecting

Fig. 19.

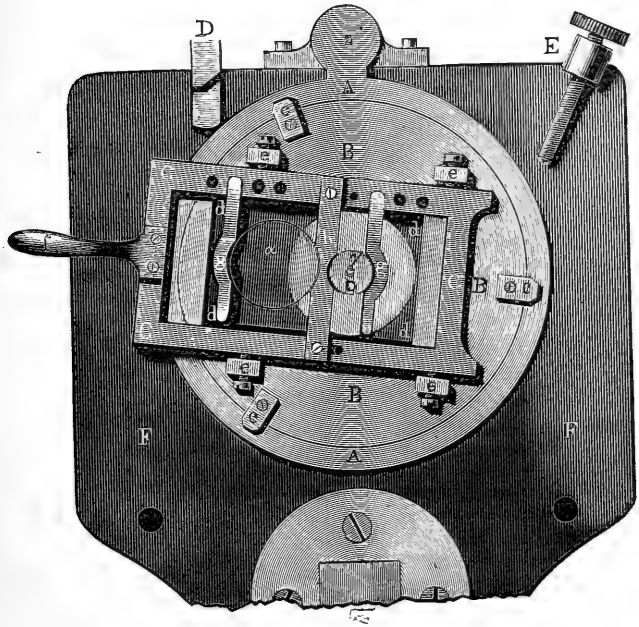


Fig. 20.

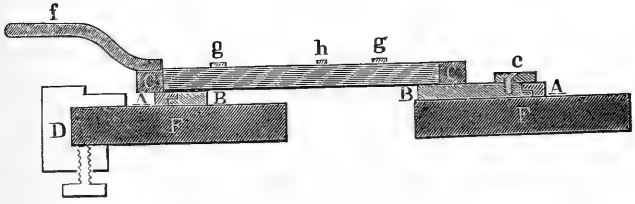
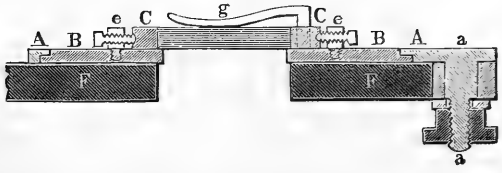


Fig. 21.



Microscope and moving pendulum-wise on the axis *a*. Within the ring is a disc B moving round the middle point *b*; the disc is provided with

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 330–6 (3 figs.).

three small bearing-plates *c c c*. The circle-segment which the middle point *b* describes when the apparatus is moved must accurately intersect the middle of the field of view. The movement of the ring A is limited on the left side by the clamp D, which is movable, and can be fixed in any desired position by a screw. On the right the motion is confined by the adjusting-screw E attached to the stage F. The disc B, perforated by the quadrangular opening *d d d d*, carries the frame C which is fixed to B by the binding-screws *e e e e*. To the left of the frame is the handle *f*, having a slight tilt upwards. In the long sides of the frame C are grooves in which the screws *e* work; if the latter are drawn out, the frame can be moved in the direction of its length. The frame C carries a glass plate, two springs *g g*, and a narrow plate *h*; these last three lie upon the glass so as to leave spaces for the insertion of cover-glasses *α* and *γ* of 10 and 6 mm. diameter, the former carrying the specimens from which are selected those to be arranged on the latter.

It follows, therefore, from the construction of the apparatus, that if the centre of the cover-glass *γ* coincide with the central point *b*, the central point of the field of vision will revolve round its own axis when B is turned, provided that the clamp D is so adjusted that the outer frame A touches it. Similarly, when the frame is properly adjusted to E, the centre of *α* will remain in the field of view.

The chief advantage of this instrument consists in its automatic precision, the hair used for arranging being always within the field of view and under the control of the preparer.

Hildebrand's Slide-carrier.*—In Dr. H. E. Hildebrand's contrivance (figs. 22–24) the stage is fitted with a circular frame R, in which is inclosed

Fig. 22.

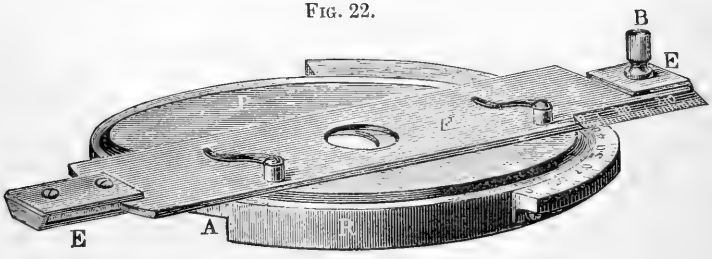
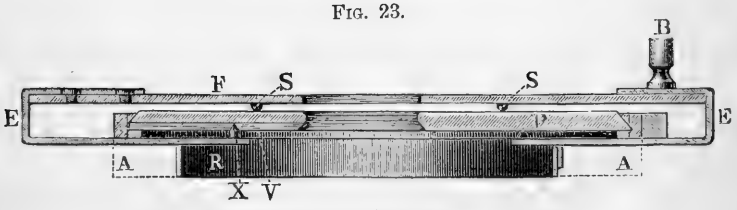


Fig. 23.

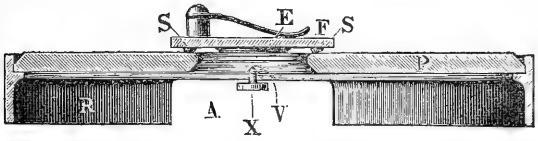


a glass plate P with a central aperture. The slide-carrier proper is a metal plate F, with a circular opening in the middle. This plate moves over

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 386–9 (3 figs.).

the glass on four pegs S, and is kept in position by the square springs E, for the passage of which two sections A of the frame R are removed. Running from the left section A directly inwards as far as the central aperture is a groove V, 1 mm. deep, on the under surface of the glass plate P. In this groove works a short guide-pin X, connected with the end of the left rectangular spring E. When pressure is made on the handle B

Fig. 24.



the carrier is moved to and fro along the groove, or in arcs of which X forms the centre, or in a combination of the two movements. As the figs. show, a finder can be employed.

The apparatus admits of some modifications, such as having the upper surface of the glass plate grooved instead of the lower.

(7) Miscellaneous Matters.

The New Glass.*—In an article widely copied by the American daily press from the 'St. Louis Dispatch' occur some rather startling statements concerning the discoveries of "Prof. Abbey" and "Dr. Scott," of which the following is a very brief extract.

"That a recent wonderful discovery in microscopy has not been even noted in the public press may be cited as proof of the general apathetic tendency as regards scientific matters. The Microscope has always been regarded as a wonderful instrument, but by the discovery of an entire new kind of glass lately, its powers are increased to an incredible degree. . . . With the old glass the full power of the Microscope was the discernment of the one-five-hundred thousandth part of an inch, and with the new glass it is claimed that the one-two-hundred-and-four-million-seven-hundred thousandth part of an inch can be distinguished. This certainly seems incredible, but positive assurance of its truth is given by parties who have tested Prof. Abbey's and Dr. Scott's new instrument."

Errors of observation in reading divided instruments.†—Herr H. F. Dorst has endeavoured to compare the relative accuracy of the three methods by which fractions of the divisions on graduated instruments are determined in making measurements; these are (1) direct estimation, (2) measurement by vernier, (3) measurement with micrometer Microscopes, and the errors corresponding to them may be called respectively estimation-, coincidence-, and adjustment-errors.

To compare these the author made a large number of observations with the naked eye upon various instruments and with sets of lines ruled upon paper, having previously determined that his eye could be regarded as one of normal accuracy and sensitiveness. The observations were made with the graduations both in horizontal and vertical positions, and the probable

* Micr. Bulletin (Queen's), iii. (1886) pp. 35–6.
† Zeitschr. f. Instrumentenk., vi. (1886) pp. 383–7.

errors were calculated by the method of least squares. The following were the results:—

Estimation error, ·015 to ·059 mm.;
Coincidence error, ·002 to ·014 mm.;
Adjustment error, ·0018 to ·034 mm.

The author concludes from his experiments that from an interval of a certain magnitude the relative error of estimation (that is the ratio of the error to the interval) increases as the latter diminishes; this increase of relative error is, however, not rapid enough to involve an increase in the absolute error of the measurement, so that using the naked eye it is possible to measure more accurately with fine than with coarse graduations.

Carlisle Microscopical Society and Dr. Dallinger.—Dr. Dallinger, P.R.M.S., in accepting an invitation to be an Honorary Vice-President of the Carlisle Microscopical Society in place of the late Dr. Carpenter, wrote to Mr. C. S. Hall, the President of the Society,—

"I have delayed writing in detail up to this time, in the earnest hope that I might find time to say something to the Society in my letter that would give direction, or stimulus, to the work it so wisely undertakes. But the pressure upon me by the claims of work, compulsory or self-imposed, is so great, that I fear if I delay until I can do, in relation to my words of direction or help, as I would, I shall do nothing. I therefore write the rather to express my deep anxiety that the members of your Society should first of all keep, individually and collectively, before them the fact, that the *raison d'être* of the modern Microscope is its scientific employment. This can only be the result of a complete mastery of the instrument in all its details. The capacity to bring out what the highest optical skill has put into a lens, is one that in this day, when objectives of the first quality are of such a high order of merit, cannot be overestimated. We may determine on a certain line of delicate investigation, say the working out in persistent continuity of the life-history of some typical form of a group of Infusorians of a relatively large size (and splendid work is waiting to be done in this direction), yet, unless the worker is master of his lenses—able, that is to say, to make them *obey* him without difficulty, yielding precisely the results he wants, and not wanting anything from them that they cannot yield; making the utmost and best use of aperture, collar, and fine-adjustment; and knowing accurately what eye-piecing any given lens will admit of. These and many other things are of the utmost importance. But they imply steady effort and practice: these, with a fair knowledge of the construction of the instrument, are the keys to success, and they can be acquired by any resolute man. But beyond this the management of light and illuminating apparatus is of the first importance. If anything, this is more difficult to fully master than the efficient employment of the lens; for the use of the lens to its utmost capacity depends upon it. But it is equally within the reach of the resolute. It is when a man is master of his Microscope, as the skilful organist is of his organ, that he will enter without hesitancy, and with certainty of result, upon such investigations as, in every department of biology, and indeed of science, invite the interest and effort of the microscopist.

Of course, what I have said applies in increasing ratio to the higher power lenses. But it has also a meaning when applied to *any* power. Relatively very few amateurs have discovered the outside power of their lenses. I can see that by the use of the new achromatic lenses, the difficulty of the use of high powers of great aperture will be lessened; but perfect

mastery of the difficulties and peculiarities of our instrument is the absolutely essential precursor to successful work of any original kind, in any direction we may choose.

I note with great pleasure that several of the provincial societies are making manipulation special, and employing demonstrations in histological methods, microscopical dissections, mounting of various kinds, &c. It would be a great gain, in my judgment, in all such societies, to have similar and progressive demonstrations on the practical use of all lenses and all apparatus employed to secure their highest efficiency, in various kinds of investigation. No doubt it may be said that small societies are not always possessed of such members as could give this desirable information. This is true: but the society exists to secure this end; and since application, with such lenses and apparatus as may be within reach of the members, is all that is required in addition to ordinary intelligence, each member may advance, and the most efficient help and stimulate the rest."

Chérubin d'Orléans' 'La Vision parfaite.'—Père Chérubin d'Orléans was the first known inventor of the Binocular Compound Microscope, which he described and figured in his work, 'La Vision parfaite,' published in Paris in 1677, * the Latin edition, 'De visione perfecta,' translated by himself, being issued at the same time. Numerous references to this work have appeared from time to time in the literature of the Microscope; but hitherto the second volume, which was published in Paris in 1681, was entirely unknown, the first volume giving no indication, either on the title-page or otherwise, of the existence of a second. In a recent visit to Antwerp we were surprised to discover a copy of the work with the two volumes bound together. This second volume † is of special interest in microscopy, from the fact that it contains a full description, with figures, of Chérubin's 'Microscope Universel,' in which is described the first application (so far as we are aware) of a rotating disc of object-lenses. There are eight different powers, applied at the nose-piece of the body-tube, a system practically identical with that adopted in England sixty or seventy years later by B. Martin. This was probably suggested to Chérubin by his rotating object-disc, which he figured (plate 31, fig. 7) and described (p. 262) in his 'Dioptrique Oculaire,' published in Paris in 1671.

Value of the Microscope in Trade.‡—"D." points out of what infinite value the Microscope is in trade; and of trades selects that of brewing, "because it will be apparent to all readers that a brewer without a Microscope is almost analogous to a peacock without a tail."

Since the remarkable revelations of M. Pasteur, the brewing trade has been completely revolutionized, and a man nowadays who does not know how to use the Microscope, and who, in fact, is not an able manipulator of that instrument, does not come within the definition of master brewer. "Science has so beautified the labours of the brewers, that they have been elevated above the level of empiric soup-makers to that of, at least, semi-professional men;" and he doubts not but that "time's effacing fingers will ere long entirely sweep away the old ignorant class of men who perhaps knew well how to wash a barrel, but had no idea of the influence of certain salts and organisms on the character of their malt extract."

After pointing out the value of the Microscope in determining,

* Chérubin d'Orléans, 'La Vision parfaite: ou le concours des deux axes de la vision en un seul point de l'objet,' xxvi. and 187 pp., frontispiece, and 16 pls. and 4 figs., fol., Paris, 1677. See this Journal, 1882, p. 253.

† 'La Vision parfaite: ou la veue distincte par le concours des deux axes en un seul point de l'objet,' tome ii., xxviii. and 239 pp., 12 pls., fol., Paris, 1681.

‡ Engl. Mech., xliv. (1886) p. 391 (3 figs.).

indirectly, the purity of the air in the fermenting rooms, &c., and the important part it plays in the analysis of water, he refers to the determination of the quality of the yeast as by far the most important use of the Microscope to the brewer. "The presence or absence of certain bacteria is of vital importance, as it is these foreign organisms that cause the unhealthy fermentations that used to perplex brewers so much; but which (thanks to such men as Pasteur, Huxley, Tyndall, Lister, Budd, and others) they are now learning to detect and remove. The germs most frequently found contaminating yeast are *Bacterium lactis*, *B. aceti*, and *B. amylobacter*, and it is these three that are familiar—too familiar—to most brewers. We now know that a healthy yeast-cell should not be larger than 1/2000 in. in diameter, and as a micrometer is an indispensable adjunct to every brewer's Microscope, the size is easily measured. We know that the absence of any vacuole in the cell denotes the plant to be too young, and not fit to induce a vigorous fermentation, and that the presence of more than three vacuoles and a shrivelled cell, at once points out the yeast to be too old. We learn from the presence of an undue amount of lactic and other ferments, when it is time a change of yeast was sought, and the 'change' having arrived, we can examine it before using, and determine the age and quality of the purchase."

The author adds that as this is intended for non-professional readers, he will not enter into any lengthy detail. "This is merely to show that, whilst the Microscope affords a most pleasing recreation to many men, and a deep life-study to others, its value to a trader is not the least of its uses. The growing taste for microscopical research amongst men is a sure sign of the intellectual age in which we live; and now that a good instrument can be purchased for such a small outlay, it behoves all men to get as deep an insight as possible into the wonders of the world around us."

(8) Bibliography.

American Society of Microscopists.

[Recommendation of Washington for the next meeting.]

The Microscope, VI. (1886) p. 273.

BEHRENS, W.—**Berichtigung.** (Correction.)

[Angry remonstrances as to his not having been furnished with the earliest information as to the new glass and objectives, instead of having to take his account of them from this Journal.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 393–4.

Bolton, Thomas, F.R.M.S.

[Grant of a Civil List pension of 50*l.* per annum.]

Midl. Naturalist, X. (1887) pp. 22–4.

BOSTWICK, A. E.—**On a means of determining the Limits of Distinct Vision.**

["Let a ruler lean against the shade of a lamp; place the eye so near that the image is necessarily blurred, and, moving the edge of a sheet of paper back and forth before the eye, step slowly backward till apparent motion of the object ceases; continue the backward movement until the object begins to recede slightly from the screen; the space where there was no motion is that in which alone distinct vision is possible. Of course, every effort must be made to accommodate the focus of the eye to the object during the whole experiment. It is a more difficult task than one thinks, to decide by simple judgment whether an object is distinctly seen or not, except it be much blurred. If the image is fairly distinct, most people will suppose it to be perfectly so. The test described above never fails to show whether or not the judgment is correct."]

Science, VIII. (1886) p. 232 (1 fig.).

BURRILL, J. T.—**Bacteria and Disease.**

[Presidential Address to the American Society of Microscopists, 1886.]

St. Louis Med. and Surg. Journ., LI. (1886) pp. 131–45.

CHRISTIAN, T.—**[Slide for testing Astigmatism of the eye.]**

["Mr. Christian exhibited an interesting test slide (his own preparation) ingeniously mounted, with a view to discover any astigmatism of the eye. It consists partially of diatoms of the *Navicula* shape. If the eye of the observer

can see simultaneously all the lines of the objects in the field well defined and resolved, then his eye is practically without astigmatic defect. The object of this important test-slide is very obvious, as incomplete perceptions are often erroneously attributed to the inferiority of the objective used, when in fact they are the result of an astigmatic defect in the observer's eye. Results of observations among microscopists often differ because the operators of instruments are frequently not aware of the astigmatic condition of their eyes."]

Amer. Mon. Micr. Journ., VII. (1886) p. 220.

CZAPSKI, S.—**Mittheilungen über das glastechnische Laboratorium in Jena und die von ihm hergestellten neuen optischen Gläser.** (On the Jena Glass Laboratory and the new kinds of optical glass made there.)

[Cf. Journal, 1886, pp. 316 and 849.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 335–48 (2 figs.) *concluded.*

D.—**The Value of the Microscope in Trade.** [*Supra*, p. 157.]

Engl. Mech., XLIV. (1886) pp. 391 (3 figs.).

DEBES, E.—**Hilfsapparat zum Aussuchen und Legen von Diatomaceen.** (Apparatus for selecting and placing diatoms.) [*Supra*, p. 153.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 330–6 (3 figs.).

DIDELOT, L.—**Du pouvoir amplifiant du Microscope. Détermination théorique et expérimentale.** (On the magnifying power of the Microscope. Theoretical and experimental determination.) 54 pp. and 1 pl., 4to, Lyon, 1886.

DIPPEL, L.—**Die apochromatischen Objective und Compensationsoculare von Carl Zeiss.** (The apochromatic objectives and compensation oculars of Carl Zeiss.)

[Cf. Journal, 1886, pp. 316 and 849.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 303–19.

DORST, F. J.—**Ueber die Grösse der Beobachtungsfehler beim Ablesen eingetheilter Instrumente.** (On the extent of the errors of observation in reading-off divided instruments.) [*Supra*, p. 155.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 383–7.

EVANS, F. H.—**Photo-micrography.** [*Post.*]

Journ. and Trans. Phot. Soc., XI. (1886) pp. 25–9 (1 fig.).

GAGE, S. H.—**Microscopical Notes.**

[1, 2, and 3, see *β*. 4. Paper for cleaning the lenses of objectives and oculars, *post*. 5. See *β*.]

The Microscope, VI. (1886) pp. 265–8 (2 figs.).

Glass, the New. [*Supra*, p. 155.] *Micr. Bulletin* (*Queen's*), III. (1886) pp. 35–6.

Grunow's Physician's Microscope. [*Post.*] *The Microscope*, VI. (1886) p. 245 (1 fig.).

HEURCK, H. VAN.—**Notice sur une série de photomicrogrammes faits en 1886. Note sur les chambres photographiques jointes à l'envoi.** (Note on a series of photomicrographs made in 1886. Note on the photographic cameras accompanying.) [See *infra*, p. 182.]

Bull. Soc. Belg. Micr., XIII. (1886) pp. 5–11.

HILDEBRAND, H. E.—**Ueber einen einfachen und sehr gebrauchsfähigen Objectführer.** (On a simple and very useful object-carrier.) [*Supra*, p. 154.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 386–9 (3 figs.).

Hillhouse, W.—See *Strasburger, E.*

JAMES, F. L.—**American Society of Microscopists**—The Chautauqua Meeting.

[Report of the meeting and editorial comments on the apathy of the Chautauqua people, and on the conduct of a member who at the Soirée exhibited to a mixed assemblage "living" human spermatozoa, under the description of "the germs of life."]

St. Louis Med. and Surg. Journ., LI. (1886) pp. 153–7.

" " Ditto.

["Mr. E. H. Griffith, of Fairport, N.Y., the originator and for several years past the superintendent of the Working Session of the American Society of Microscopists, is very much chagrined at a mistake which occurred at Chautauqua, and which cost him and the Society several valuable books, slides, and instruments. Having received from California some microscopical material for distribution, he announced the fact in open session, and told all who desired specimens to come to his table and help themselves. Quite a number of persons availed themselves of the offer and helped themselves, not only to the unmounted material, but to a large number of rare and costly mounted slides belonging to the Society, and some valuable books which chanced to be on the same table. Similarly, Mr. Griffith's offer to loan any instrument on his table to workers in the session, was taken to mean that the parties could keep what they borrowed —the result being a nett loss of four new and costly Griffith's turntables. No doubt those who took the books and slides did so under a misunderstanding of

Mr. Griffith's words, and they will promptly make reparation. Those who kept the turntables can scarcely be judged so leniently. Still it is possible that they too misunderstood the offer. At any rate, prompt reparation should be made. If it is not done, the matter should be looked into by the Society, and an example made of the persons who so abuse the privileges of membership. The 'nipping' of fine slides has become entirely too frequent to be pleasant to those who have to stand the loss. The writer's cabinet has suffered a greater or less depletion from this source at every meeting that he has attended, and the 'nippers' must henceforth be on their good behaviour or exposure will most certainly follow."]

Ibid., pp. 209–10.

L., T. F.—**"Microscopical Advances."**
[Comments on Dr. Royston-Pigott's articles, &c.]
Engl. Mech., XLIV. (1886) pp. 303–4.

Leitz's (E.) Microscopes. [Recommended for pharmacists.]
Amer. Mon. Micr. Journ., VII. (1886) p. 236, from *Western Druggist.*

Long, R.—**Instruction über den zweckmässigen Gebrauch des zusammengesetzten Mikroskopes.** (Instruction in the proper use of the Compound Microscope).
8vo, Berlin, 1886.

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[Translation by Dr. J. Pelletan of the Cantor Lectures at the Society of Arts.]
Journ. de Microgr., X. (1886) pp. 512–9.

Measures, J. W.—**Presidential Address** to the Postal Microscopical Society.
Journ. of Micr., VI. (1887) pp. 1–7.

[Micro-Jurisprudence]
["We find the development of a new branch of the legal profession in an advertisement in the *Chicago Legal News* as follows:—'Marshall D. Ewell, M.D., Attorney and Medico-Legal Counsel—Microscopic Examination of Writings, &c., and Microscopic and Micro-spectroscopic Examination of Blood, &c.—170, Washington Street, Chicago.'"]
Solicitors' Journal, 1886, p. 827.

Microscope and its Future. *The Microscope*, VI. (1886) pp. 248–51.

Moore, A. Y.—**A central-light Objective.**
[Report on Spencer objective "1/18 : 105° B.A."]
The Microscope, VI. (1886) pp. 241–2.

" " **Gold-plated Diatoms.**
["From A. Y. Moore we have received another novelty, namely, preparations of the diatom *Arachnoidiscus*, plated with gold by electricity. These make very rich and elegant objects, and present some interesting features, among which may be noted the prominence with which the rays or ribs stand out. Dr. Moore states that 'by making the diatom opaque, points of structure may be determined which probably would not otherwise be seen.' Certainly, independent of any scientific value they may have, these slides constitute a very attractive novelty."]
Micr. Bulletin (*Queen's*), III. (1886) p. 35.

N., W. J.—**The Two Mirrors** (*contd.*) [*Post.*] *Sci.-Gossip*, 1886, pp. 265–8 (2 figs.).

Nelson, E. M.—**A method of finding out the general character of the components of a cemented combination.**
[*Supra*, p. 151.] *Engl. Mech.*, XLIV. (1886) pp. 320–1 (3 figs.).
Journ. Quek. Micr. Club, III. (1887) pp. 13–7.

Objectives, new Apochromatic.
Journ. Quek. Micr. Club, III. (1887) pp. 22–4 (T. Curties and J. E. Ingpen)—*Micr. Bulletin* (*Queen's*), III. (1886) p. 46 (G. A. Piersol)—*Naturforscher*, XX. (1887) pp. 29–31.

Outerbridge, G. E., Jun.—**The Limit of Thinness.**
[Gold leaf on glass plates not more than the 1/400,000 mm. thick.]
Scientific Enquirer, II. (1887) pp. 9–10.

Pelletan, J.—See *Mayall, J., Jun.*

Pennetier, G.—**De l'enseignement de l'histoire naturelle et de la micrographie commerciale.** (On the teaching of natural history and on commercial microscopy.)
[Address to the International and Industrial Congress at Bordeaux, 1886, advocating natural history being placed on the same footing as physics and chemistry in the "Cours de Marchandises" of the Higher Schools, with a laboratory for microscopical technique as applied to commerce and industry.]
Journ. de Microgr., X. (1886) pp. 486–93.

PSCHEIDL, W.—**Bestimmung der Brennweite einer Concavlinse mittelst des zuzammengesetzten Mikroskops.** (Determination of the focus of a concave lens by the compound Microscope.) *SB. K. Akad. Wiss. Wien*, XCIV. (1886) pp. 66–70.

Quimby's (B. T.) Slide-carrier.

[Two thin pieces of wood, rather larger than a slide, with a round hole piercing their centre. Narrow strips of sufficient thickness are fastened between the top and bottom pieces, dividing the interspace into three compartments, into the middle of which a square of blue glass may be inserted, while the end spaces are for the clips. In the upper surface of the carrier behind is a ridge to prevent the slide from slipping down.]

The Microscope, VI. (1886) pp. 269–70.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XV.**

[On the circular solar spectrum.] *Engl. Mech.*, XLIV. (1886) p. 337 (9 figs.).

SARGENT, T. L.—See Wells, S.

SCHRÖDER, H.—**Notiz in Bezug auf Korrektion des sekundären Spektrums.** (Note on the correction of the secondary spectrum.)

[Having examined about fifty varieties of glass used by Ross and Co., from Dollond's time, and having determined the constants of each for the seven principal lines of the spectrum, he found three varieties which are suited to secure the absolute coincidence of any three lines in the spectrum; these are dense English flint, a crown glass of high dispersion and relatively low index made exclusively for Ross and Co., and a variety of plate glass containing a high proportion of aluminates which has a mean index as great as that of the crown glass. A good achromatic compound Ross Microscope being used as eye-piece, it was found that (the objective being small) absolutely no secondary colours were to be observed either at the focus or away from it, although the calculations point to the existence of such. By the combination of both sorts of crown with light English flint coincidence of the lines D E G was attained, and a combination of both sorts of crown with dense English flint was made to ensure coincidence of the lines B D G.]

Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 205–6.

Science Directory. *Sci.-Gossip*, 1886, p. 256.

Science in 1886.

["The new optical glass which has been invented by Abbe, of Jena, is of great interest, especially among microscopists, vastly improving the observing power of the instruments with which they work."]

Times, 6th January, 1887, p. 3.

STEIN, S. T.—**Das Licht im Dienste wissenschaftlicher Forschung.** (Light as an aid to scientific research.) V. Die Photogrammetrie, Militärphotographie und Optische Projektionskunst. (Photogrammetry, military photography, and the art of optical projection.) 2nd ed., viii. and 146 pp. and 170 figs., 8vo, Halle, 1887.

Stenglein's Mikrophotogramme zum Studium der angewandten Naturwissenschaften. Lief. I. 16 pp. and 12 photomicrographs, Berlin, 1886.

Strasburger, E.—**Handbook of Practical Botany for the Botanical Laboratory and Private Student.** Edited from the German by W. Hillhouse. Revised by the author and with many additional notes by author and editor. [*Supra*, p. 120.]

xxiv. and 425 pp., 134 figs., 8vo, London, 1887.

[Also edition in Russian, xiv. and 304 pp., 114 figs., 8vo, Moscow, 1886.]

TASCHENBERG, O.—**Bibliotheca Zoologica II.** Verzeichniss der Schriften über Zoologie welche in den periodischen Werken enthalten und vom Jahre 1861–1880 selbständig erschienen sind. (Index to the zoological papers contained in periodicals and which have appeared separately from 1861–80.)

[Continuation of Carus and Engelmann's Bibliotheca Zoologica, 1846–60. Parts 1 and 2 contain a bibliography of the Microscope and microscopical technique, pp. 279–348, including A. C. Swinburne's 'Under the Microscope'!].

8vo, Leipzig, 1886.

TREAT, M.—See Wells, S.

W.—**Ausstellung wissenschaftlicher Instrumente, Apparate und Präparate.** (Exhibition of scientific instruments, apparatus, and preparations.)

[Brief description of the Exhibition at Berlin, which included Microscopes and polarization and photomicrographic apparatus.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 348–52, 388–91.

WALES, W.—**A Cover-carrier for Immersion and Dry Lenses.** [*Post.*]

Journ. N. York. Micr. Soc., II. (1886) pp. 125–6.

WELLS, S., TREAT, M., and SARGENT, T. L.—**Through a Microscope:** something of the science, together with many curious observations, indoor and out, and directions for a home-made Microscope. iii. and 126 pp., 8vo, Chicago, 1886.

WINKEL, R.—**Apparat zum Markiren mikroskopischer Objecttheile.** (Apparatus for marking parts of microscopic objects.)

Title only of German Patent, Kl. 42, No. 4365.

WOOD, R. W., Jun.—**A simple Polariscope.**

[Black glass substituted for the mirror for the polarizer. Eighteen circular cover-glasses for the analyser.]

The Microscope, VI. (1886) pp. 268–9 (1 fig.).

Zeiss's (C.) Ten Thousandth Microscope.

[He "recently placed in a box with his own hands the ten thousandth Microscope he has made."]

The Microscope, VI. (1886) p. 284.

β. Collecting, Mounting and Examining Objects, &c.*

(2) (*b*) Preparing Special Objects.

Preparing Eyes of Mammals.†—The eyes of certain mammals used by Dr. A. Dostoiewsky were hardened in Müller's fluid for periods varying from a few days to several months. Many of the eyes had previously been placed for 24–48 hours in a 2 or 3 per cent. chromic acid solution. For cutting, the anterior half of the eye was imbedded in celloidin used in three different strengths (thin, medium, and thick). In each of these solutions the preparation was left for at least 24 hours. It was afterwards immersed in a mixture of 2 parts of ordinary spirit and 1 part of water. The direction of the sections was meridional, transverse, and tangential. For staining, Böhmer's hæmatoxylin and eosin were exclusively used. The logwood solution was several months old, and very weak. This device prevented the celloidin from becoming stained.

Preparing Eyes of Birds.‡—Dr. W. B. Canfield, in his researches on the accommodation apparatus of the bird's eye, employed Semper and Fredericq's method for dry preparation, and also the celloidin process. The eyes were fixed in Müller's fluid, and then hardened in spirit. For decalcification, saturated solution of picric and chromic acid, and nitric acid 2 per cent. were used. The eyes were then imbedded in celloidin by Czermak's method, and the sections, stained with hæmatoxylin and eosin, were mounted in balsam.

Preparing Molluscan and Arthropod Eyes.§—In elucidating the structure of molluscan and arthropod eyes, Mr. W. Patten notes the satisfactory results obtained by the following methods:—When sections were not resorted to, the tissues were hardened a very little and then macerated. The use of chromic acid had to be varied in strength and temperature, &c., for different regions; it was found especially useful to shift in half an hour from a one-tenth per cent. to a one-twentieth, in 24 hours back again to one-tenth, in 24 hours to a one-fifth, where it was kept for 48–60 hours. The cornea was best treated with picro-chromic, the lens with picro-sulphuric, the layer of nerve-fibres below the septum with one-fifth per cent. chromic acid for 24 hours, the retinophoræ with chromic, the rods and retinidia with one-fifth per cent. chromic at 50° C. for half an hour. The best preparations, with all the parts in the most natural position, were

* This subdivision contains (1) Collecting Objects; (2) Preparing, (*a*) in general, (*b*) special objects; (3) Processes prior to making sections; (4) Cutting, including Imbedding and Microtomes; (5) Staining and Injecting; (6) Mounting, including slides, cells, preservative fluids, &c.; (7) Examining objects, including Testing; (8) Miscellaneous matters; (9) Bibliography.

† Arch. f. Mikr. Anat., xxviii. (1886) pp. 91–121 (2 pls.).

‡ Ibid., pp. 121–70 (3 pls.). § MT. Zool. Stat. Neapel, vi. (1886) pp. 733–8.

obtained by killing the eyes first with one-tenth per cent. chromic acid for half an hour, allowing them to remain in one-half per cent. for 24 hours, one-tenth per cent. for 24 hours, and finally one-fifth per cent. for 48 hours or more.

Demonstration of Bile-capillaries.*—For the demonstration of the biliary capillaries, Dr. M. Miura used the following methods:—A small piece of liver, after having been in Müller's fluid for 2–5 days, is washed with ordinary water and laid in distilled water for 3–5 hours. It is then transferred for 2–3 hours to a 15 per cent. watery grape-sugar solution. It is next placed for two or three days in a 0·1–0·2 per cent. solution of gold chloride. The gold solution is to be changed two or three times. Finally the preparation is again left for two or three days in the grape-sugar solution, but without access of air, until it assumes a dark violet or black colour. The bile-capillaries are stained a purple red.

Preparing Horse-hoofs.†—In Dr. C. Nörner's investigations, directed chiefly towards the discovery of nerve-fibres, the hard corneous layers were first removed from the hoof, and then small pieces of the softer tissues were cut out and placed in osmic acid and gold chloride. Pieces of tissue were placed in osmic acid (1:100) for 24–48 hours, they were then washed and stained in picro-carmine (*in toto*). In using the gold chloride, the fresh pieces were first rendered sufficiently transparent by soaking for one to five minutes in one-third formic acid. They were then transferred to a gold chloride solution (1:100 or 1:200) for 20 hours. After washing, the gold is reduced by putting the pieces in a weak solution of formic acid for 24 hours in the dark. They were then hardened in absolute alcohol and stained *in toto* in picrocarmine. The sections were first examined in dilute glycerin, and those showing numerous nerves were placed, after staining, in dilute picric acid, then passed through alcohol to oil of cloves, and mounted in balsam.

In preparations thus treated the nerves, stained dark violet to black, show up against the red background. The author does not speak encouragingly of either method, as he found that both were unsatisfactory.

For examining the histological structure of the hoof, pieces of the softer parts were stained *in toto* in Ranvier's picrocarmine, and were then hardened in alcohol. The sections were then placed in water slightly acidulated with picric acid and mounted in balsam or in formic acid glycerin; or the pieces were first cut and then stained.

Showing Mitosis in Brain of Tadpole.‡—Prof. A. Rauber has in his researches found the following methods most successful in displaying the nuclear division in the nervous system of frog embryos. For hardening, 1/3–1/2 per cent. chromic acid, and alcohol, or Flemming's mixture of chromic, osmic, acetic acids and water, were found most satisfactory. For staining, safranin solution or gentian-violet, or picrocarmine and hæmatoxylin, alone or successively, yielded the best results.

Method of Studying Development of Genital Organs of Pulmonata.§—In his account of the development of the generative apparatus of Stylommatophorous Pulmonata, Dr. J. Brock states that *Agriolimax agrestis* is a satisfactory species to cut into sections for the purpose of orientation when

* Virchow's Arch. f. Pathol. Anat., xcix. (1885) pp. 512–21 (1 pl.).
† Arch. f. Mikr. Anat., xxviii. (1886) pp. 171–224 (1 pl.).
‡ Ibid., xxvi. (1886) pp. 622–44 (1 pl.).
§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 338–9.

dealing with sections of unknown forms or such as are likely to disturb the disposition of parts by coiling or contraction. The young were killed in 0·1 per cent. chromic acid solution, to which a little (1 drop to a 1 per cent. solution in a watchglass) osmic acid was added; they were then treated with alcohol of increasing strength, coloured *in toto*, carefully dehydrated, and cut by Jung's microtome into sections of 1/120 mm. thick. Staining was effected with alum or borax-carmine; occasionally combinations of the two gave excellent effects. In a footnote the author remarks that the finest and most precise colorations of nuclei are got with alum-carmine, in the case of molluscs and vertebrates; with Arthropods the coloration is less intense and certain, owing to a peculiar swelling of the tissue.

Preparing Sections of Stem and Root.*—In his investigation of the origin of lateral roots in Dicotyledons, M. A. Lemaire found that sections simply hardened in alcohol were not available, owing to the contraction of the protoplasm; and the same objection applies to the use of calcium chloride; the presence of tannin is also a serious obstacle to their examination. M. Lemaire finds the following process produce good results. The section is first placed in the solution of sodium hypochloride known as *eau de Labarraque*, until the colouring matters are entirely destroyed and the nucleus and protoplasm dissolved, the cell-walls being left intact. This requires a submersion of from 15 to 20 minutes; but one to two hours produces no bad effect. The best staining material is then anilin-brown, which he uses as a solution of 3–4 per cent. in absolute alcohol. The preparations after being repeatedly washed in distilled water, are placed in drops of this fluid for some minutes, then immersed in absolute alcohol, and finally in oil of cloves until they attain the desired transparency; and finally mounted in Canada balsam. Sections prepared in this way are remarkably clear, and may be preserved for a long time. Mounting in glycerin does not answer so well. The process will apply to the study of all merismatic tissues.

Preparing the Epidermal Tissues of Pitcher Plants.†—Dr. J. M. Macfarlane states that the difficulty he experienced in getting clean and large pieces of the epidermis from the different surfaces of pitchers induced him to try various methods of preparation. Maceration in caustic potash solution of 2 per cent. strength gave admirable results. The pitchers to be macerated were placed whole in beakers containing the solution, and boiled over a Bunsen flame for from 10 minutes to 2 hours. The pitchers of *Nepenthes*, if young and fresh, had both outer and inner epidermis loosened from the green cellular and fibrovascular systems after about 15 or 20 minutes' boiling; old or dried pitchers required 30 to 60 minutes. By floating them afterwards in clean water both epidermal layers could be detached with great ease. Pitchers of *Cephalotus* were macerated after 10 to 20 minutes' treatment, but those of *Sarracenia*, *Heliamphora*, and *Darlingtonia*, except when young and tender, required boiling for about 2 hours, with subsequent maceration for 2 or 3 weeks in water.

In this way not only could long pieces be obtained for continuous microscopic examination of the surfaces, but bottled hand specimens of the entire inner epidermis of *Nepenthes* could be made, showing clearly to the naked eye the attractive, conducting, and secreting surfaces, with associated glands. Similar treatment of leaves for preparations of hairs, water and air stomata, &c., give equally good results in many cases.

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 172–4.
† Rep. 55th Meeting (1885) Brit. Assoc. Adv. Sci., 1886, p. 1088.

Preparing Lactarius to show Branched Laticiferous Vessels.*—Dr. A. Weiss finds that pieces of *Lactarius deliciosus* should not be kept too long in spirit, and that sulphuric acid shows the course of the vessels very plainly, the contents of the tubes assuming quickly a blue-black colour. The surrounding tissue being greatly affected by the reagent, the laticiferous vessels appear still more clearly, and slight pressure on the cover-glass serves to separate them for some distance. Iodine water imparts to the tubes and their contents a trace of green, which is rendered more intense by potash, and the juice appears in large dark-orange coloured drops. The colour afterwards passes into brown. Ferrocyanide of potash, sulphocyanide of potash, nitrate of silver, bleach the juice. Platinum chloride, cobalt oxide, chromic acid, and potassium bichromate have no effect; gold chloride stains the vessels blue-black, the hyphæ greenish yellow. Sulphuric acid stains the contents of the vessels yellow, yellowish green, greenish black, and finally blue-black; the contents of the hyphal filaments rose-red. Iodine solution brings out a very dark almost black colour in the vessels.

Solution of Starch in Leaves.†—M. L. Brasse describes the manner in which a diastatic ferment can be extracted from green leaves. The leaves are bruised in a mortar and covered with cold water; after twenty-four hours they are pressed, 1½ volumes of 90° alcohol added, and the juice filtered. The same quantity of alcohol is again added to the filtrate and the precipitate thrown on a filter, and rapidly washed with alcohol of 65°. The diastase is obtained in solution by dissolving the washed precipitate in water and filtering.

New Reagent for Coniferin.‡—Dr. H. Molisch describes the mode of preparation and action of a new reagent for coniferin. We have hitherto been indebted to the reaction with phenol and hydrochloric acid for the identification of coniferin in plant tissues. A section containing coniferin, one of pine-wood for instance, if moistened with this reagent, gives in direct sunlight an intense yellow-green or blue-green or sky-blue. By the aid of this the general diffusion of coniferin in lignified tissues was recognized firstly by F. Tiemann and W. Haarmann, and then by v. Höhnel and Singer; in fact, this glucoside is stated to be always present in woody tissues or in lignin. During the study of two new sugar reactions,§ the observation was made that thymol colours woody tissue a striking blue-green in the presence of concentrated hydrochloric acid.

The observation was carried out as follows:—A 20 per cent. solution of thymol in absolute alcohol was first prepared; with this a section of pine-wood was moistened, and as much hydrochloric acid added as would fill the space between the cover-glass and the glass bearing the object. In a few minutes a green colour developed, which soon turned to blue-green or blue; or, if the above had taken place in direct sunlight, the colour would be almost immediately a deep sky-blue.

The author then quotes from a paper of T. and D. Tommasi, published in 1881, which pointed out the fact that a greater intensity of colour is obtained when working the phenol-hydrochloric acid reaction, if previously some potassium chlorate be added to the acid. Taking advantage of this result, the following reaction is used by the author as being the most

* SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

† Ann. Agronom., xii. pp. 200–3. See Journ. Chem. Soc. Lond.—Abstr., l. (1886) p. 827.

‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 301–5.

§ See *infra*, p. 169.

serviceable in detecting coniferin. Water is added to a 20 per cent. solution of thymol in absolute alcohol as long as it remains clear and no thymol is precipitated. Crystals of potassium chlorate are then added in excess, and the solution is allowed to stand several hours, and filtered. Some paper which contained only a trace of coniferin was taken and moistened with this liquid, and a drop of concentrated hydrochloric acid added; in a few minutes, although in complete darkness, the moistened part became bluish green. With this reagent, sections from the stem of over a hundred woody and herbaceous plants were tried, and always with a positive result. In all the sections the lignified portions only became blue; in the first place the walls of the xylem-elements, then those of the pith and the bast-cells.

Finally, the author refers to a paper of Wiesner's, who states that he obtained a red-violet colour when phloroglucin, lignin, and hydrochloric acid are brought together. The presence of phloroglucin in some measure conceals the reaction for coniferin; but not so much so as to make it altogether inapplicable.

Engelmann's Bacterium-method.* — Dr. N. Pringsheim replies to Engelmann's further defence † of the accuracy of this method of determining the intensity of the evolution of oxygen in plants under the influence of sunlight. He reasserts the inadequacy of the method of successive observations, from the inconstancy of the minimum width of the cleft needful for the movement of the bacteria in the different colours. The movement can often be followed up to the disappearance of the object, and it usually ceases in all colours at nearly the same width of cleft, which, in direct sunlight, is about 0·008 mm.; while, on the other hand, the minimum widths for the visibility of the movement in the different colours of the spectrum—red, yellow, green, and blue—do not stand in a constant relationship to one another, as required by Engelmann's theory.

Preparing the Bacillus of Lustgarten.‡—MM. Alvarez and Tavel have modified Lustgarten's method as follows: instead of sulphuric acid they use 2 per cent. oxalic acid; a stay of two hours in the warm solution they find sufficient; and they double stain with eosin, picro-carmine, and safranin. They approve De Giacomi's method if the iron chloride be strongly acid. Against Lustgarten they maintain that the syphilis bacillus, like that of tubercle, strongly resists decolorization by acids (33 per cent. nitric, hydrochloric and sulphuric acids). The authors, however, mention a difference between the two bacilli, which is, that Lustgarten's microbe becomes immediately unstained by alcohol after treatment with acid: the acid must therefore be well washed out in water, if the colour is to be retained.

Method of obtaining Uric Acid Crystals from the Malpighian Tubes of Insects, and from the Nephridium of Pulmonate Mollusca.§—By the method adopted by Dr. C. A. MacMunn, he obtained abundance of crystals of uric acid from the contents of the Malpighian tubes of a single insect, and the method is therefore likely to be useful in determining whether a given organ in an invertebrate animal discharges a renal function or not.

The insect examined was *Periplaneta orientalis*. The Malpighian tubes, after crushing, were boiled in distilled water to dissolve the supposed

* SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 20, 1886. See Bot. Centralbl., xxviii. (1886) p. 93.

† See this Journal, 1886, p. 705. ‡ Arch. de Physiol., xvii. (1885) p. 303.

§ Journ. of Physiol., vii. (1886) pp. 128-9.

urate or urates, the extract evaporated to dryness, the residue extracted with boiling absolute alcohol and this extraction twice repeated, the alcoholic solution poured away, the residue again boiled in distilled water and filtered while hot. To the filtrate an excess of acetic acid was added, and after the lapse of some hours crystals were easily found with a 1/5 in. objective. These occur mostly in hexahedral plates, also in the so-called "coffin-shaped" crystals and in prismatic needles crossing each other, also in groups of star-shaped form composed of prismatic and "whetstone" crystals, and in other forms.

Some of the residue, when evaporated to dryness and nitric acid was added, effervesced; on evaporating the acid the residue was reddish. On holding a glass rod wet with ammonia close to it, a fine purple colour was seen, and on adding caustic soda instead of ammonia it showed a beautiful violet colour.

On applying the same methods to the contents of the nephridium of *Helix aspersa* a similar result was obtained, the crystals, however differing in shape and size, but corresponding, nevertheless, to the well-known forms in which uric acid is known to crystallize. Some of the crystals obtained were cubical, some hexahedral, others prismatic with truncated angles, others coffin-shaped, and so on. Both in the case of *Periplaneta* and *Helix* the size of the crystals depends on the method of preparation; for instance, they are smaller when the acetic acid solution is boiled.

The dried residue in the case of *Helix* also gave the murexide reaction distinctly, and the above-mentioned colour changes with caustic potash.

From the nephridium of *Limax flavus* similar crystals were obtained, and in this case too the murexide reaction was equally well marked.

In the juice of the nephridium of *Helix* spherical crystals are found, which have been mistaken by some observers for crystals of the colouring matter of the so-called bile of this mollusc; they probably consist of urate of soda (and calcium), and are at all events the urate of the base which yields uric acid by the above treatment. In their interior needles can be seen radiating from the centre to the periphery. It has been shown by Griffiths that the "green gland" of the crayfish can be made to yield crystals of uric acid, and he has more recently found uric acid in the organ of Bojanus of *Anodon*, but in his experiments caustic potash was used; a method open to the objection that possibly, though not probably, the reagent may have had something to do with the result; but in the present case acetic acid was the only reagent used, which is not open to this objection.

Hence it may be safely concluded that the view held that the Malpighian tubes of insects and the nephridium of the Pulmonate Mollusca function like the kidney of vertebrates is quite correct.

(4) Cutting, including Imbedding and Microtomes.

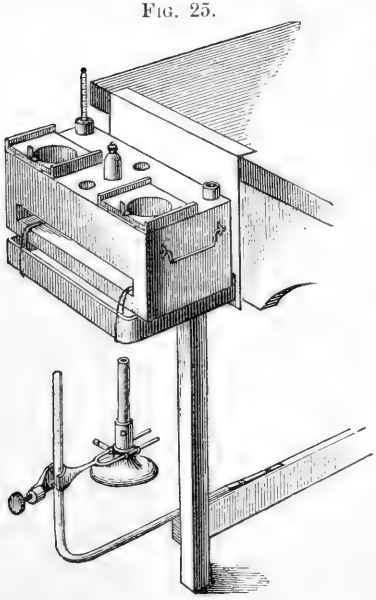
Water-bath Apparatus for Paraffin.*—Mr. E. L. Mark finds it preferable to have a water-bath for each student instead of a common tank for all, a plan which has the advantage of all the materials being close at hand. Moreover, it is more convenient to have the top of the bath nearly level with the top of the table, rather than as a tripod standing on the table. The gas-jet should be adjustable for distance in preference to the bath.

The bath (fig. 25) is a modification of that used at the Naples Zoological Station. It is fixed on a wrought-iron bracket to the end of the work-

* Amer. Natural., xx. (1886) pp. 910–4 (3 figs.).

table, so that a space of 25 to 30 mm. is left between the edge of the table and the bath. The bracket is made of band iron, 25 × 3 mm., bent into a rectangular form. The gas-burner is carried by a movable forked clamp fixed to an iron rod bent at right angles, and which is screwed to the legs of the table.

Fig. 25.



The water-bath itself is made of tin-lined burnished copper, is 18 cm. long, 9 cm. broad, and 8 cm. high, and has an oven 1 cm. high near the bottom for heating slides. The water-space communicates externally by one "chimney" only.

In the top are two large and four small copper-lined wells. One of these is 7 cm. deep, the rest 4 cm. deep. The two larger wells are 6 cm. in diameter, and each receives a copper tank provided with a handle and a nose. On either side of the larger wells copper ledges are fixed for supporting glass plates to protect from dust.

In order to fill the wells with paraffin and to support the object to be imbedded, ladles made by beating out the end of a piece of copper wire are recommended. Of the smaller wells, three are 18 mm. in diameter and are intended for 2-drachm vials. The fourth well has a diameter of 24 mm., and is intended for a mercurial gas-regulator.

Orienting large objects in paraffin.*—Mr. E. L. Mark finds that for large objects all that is necessary is to place the glass plate on which the imbedding is to be performed on the top of an ordinary glass dish (5 cm. deep and 10 cm. in diameter is a convenient size), at the bottom of which a small mirror is so adjusted as to make an angle of a little less than 45° with the horizon. With the mirror turned towards the window the outlines of the object are rendered sufficiently distinct for most purposes of orientation.

Pfeifer's Revolving Automatic Microtome.†—Mr. A. Pfeifer's microtome (fig. 26) was designed to save time and labour in the preparation of series of sections, and to attain at the same time the greatest uniformity in the thickness of the sections.

The mechanism is very simple. The frame B contains a horizontal screw beneath the sliding carriage C. The carriage carries the knife K. This carriage is moved forward by the turning of the screw. Two arms of the frame support the axis J of the revolving wheel E, to which the imbedded object is attached. The knife K is clamped in an upright position on the arms rising from the sliding carriage, so that the edge of the knife is in the same horizontal plane with the centre of the axis J. Thus, as the sliding carriage is moved by the screw, so the knife is moved to or from the revolving object. The carriage slides by means of grooves

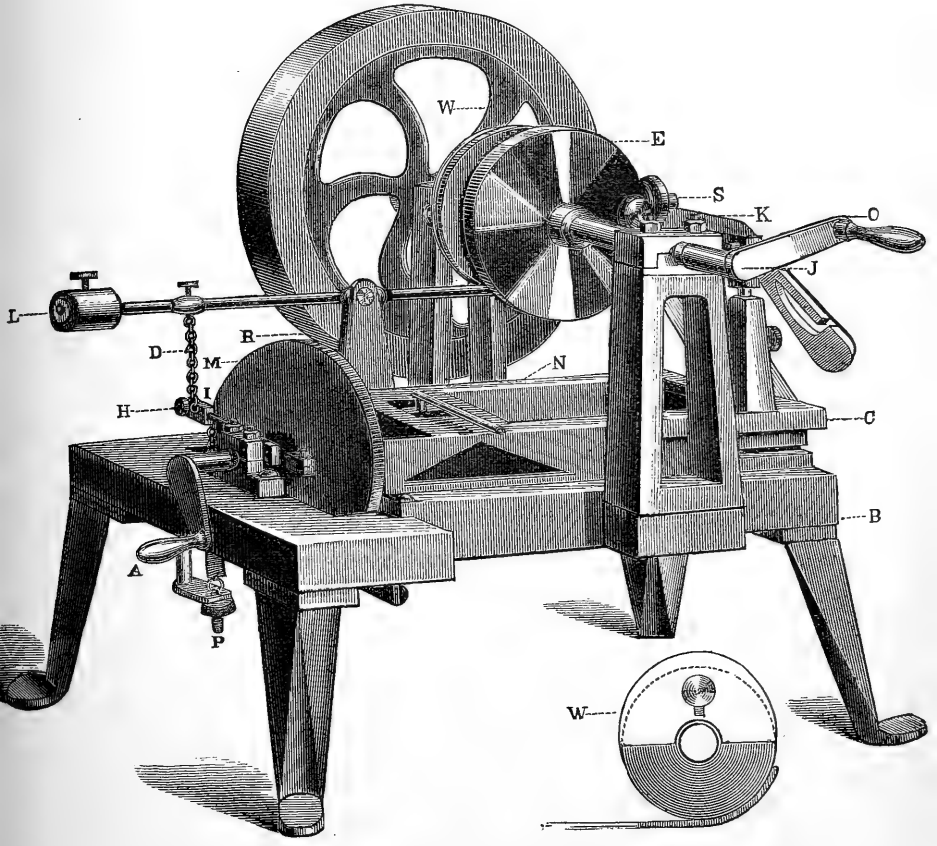
* Amer. Natural., xx. (1886) pp. 914–5.

† Studies from the Biol. Laborat. Johns-Hopkins Univ., iii. (1886) pp. 477–9 (1 fig.).

on raised tracks of the frame, and is not directly connected with the screw, but is simply pushed by the nut N. This arrangement makes it impossible that any slight eccentricity of the screw should cause a jolting of the carriage.

The head of the screw is a solid wheel M at the end of the frame, and has 250 ratchet-teeth on its circumference. The screw has 20 threads

FIG. 26.



to the inch. The knife, therefore, is moved an inch by 20 revolutions of the screw; and as there are 250 teeth to the revolution, each tooth represents $1/20 \times 250 = 1/5000$ inch.

The handle O turns the axis J, to which is attached the wheel E. This wheel is four inches in diameter, and to it is fastened the clamp which holds the object to be cut. The axis also carries a fly-wheel and an adjustable eccentric wheel W (figured separately). This eccentric moves a lever L, the long arm of which is connected with the small chain D. The chain lifts a small lever H, which works by means of a catch I on the teeth of the screw-head, causing the screw to revolve. The small lever is steadied and pulled back to its place by a spiral spring P, while another spring catch underneath the frame prevents the ratchet-wheel from turning back. By properly adjusting the eccentric wheel the levers may be made

to act so that the catch I will take any desired number of teeth by every revolution of the object. The knife moves only during that part of the revolution when the object is not in contact with the knife. The ribbon of sections slides downward from the knife and is caught on a piece of paper placed upon the table. The wheel holding the object, as well as the razor, can be moved so that almost all parts of the edge of the razor can be used.

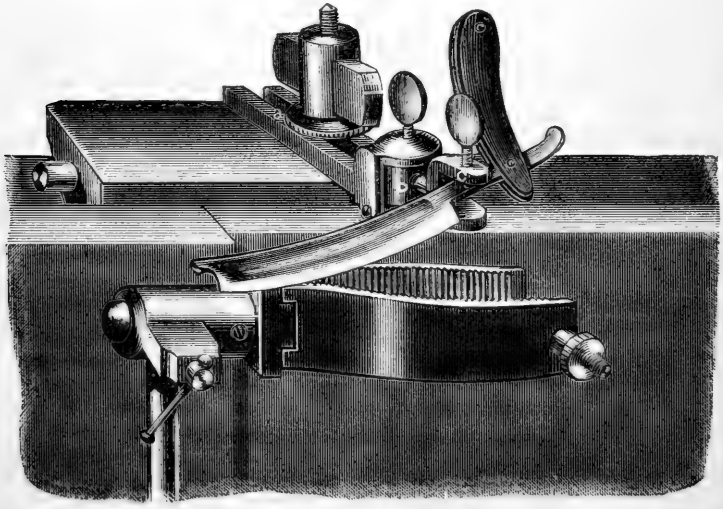
The frame-bed of the microtome is made of iron, the screw of steel, and all the rest is brass. Any ordinary microtome knife or razor may be used.

The machine has been in use at the Johns-Hopkins University at Baltimore, for a year, and gives the greatest satisfaction. It can be used with great rapidity, but so far the best results have been obtained at a rate of not over 100 sections to the minute. The only possible error in a revolving microtome of this kind is theoretical—namely, that owing to the circular motion of the object, each section is part of a hollow cylinder. But in reality, with objects of ordinary size, this error is not apparent, and even under a high magnifying power there is no perceptible difference between sections cut by this microtome and those cut by ordinary slide microtomes.

Hildebrand's Microtome.*—Dr. H. E. Hildebrand has made several improvements to his "Simple and effective Microtome" already described.† On the sides of the object- and knife-carriers excavations with roughish surfaces have been made for the reception of the thumb and first two fingers. The clamp of the knife-carrier is now made of metal and is lighter, and all the metal parts are nickeled.

Martinotti's Knife-holder for Sliding Microtomes.‡—Dr. G. Martinotti has designed a simple clamp (fig. 27) for the purpose of fixing ordinary razors to the carrier of the sliding microtome.

Fig. 27.



The arrangement consists of two clamps *a* and *c*, which are connected by a ball-and-socket joint *b*. The long bars of the clamp *a* are fixed to the

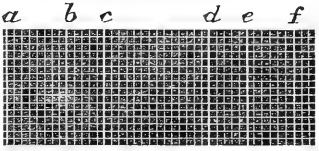
* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 392. † See this Journal, 1886, p. 886.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 390–2 (1 fig.).

carrier by a large screw. The short clamp *c* holds the razor (or even a microtome-knife). The ball-and-socket joint allows extensive motion in a horizontal direction, but the vertical movements, although sufficient, are more limited.

This simple accessory is intended chiefly for those microtomists who sharpen their own razors, and the only defect (which is pointed out by the inventor), is that it requires a certain amount of space between the slide and the object-carrier.

Determining the Reciprocal Positions of Object-points.*—For this purpose Prof. H. Strasser uses very thin paper ruled with fine lines as in fig. 28, and further subdivided by coarse vertical lines in such a way that the distances between $a\,b + e\,f = c\,d$ and $b\,c = d\,e$. A quadrilateral case is then formed of the paper thus ruled, by gumming the ends together so that the line *f* coincides with the line *a*. Within this case, supported by a metal box, the specimen is imbedded. Owing to the thinness of the paper no difficulty is experienced in making sections if the mass be cut with a very sharp knife. Each section is thus surrounded by a paper band in which vertical and horizontal marks are present. These marks are intended, *inter alia*, to aid in the recognition of the position of the section to the object.

FIG. 28.



Section-series and a new method for making Wax Modelling-plates.†—Prof. H. Strasser, in an article on the study of section-series, and on a means for facilitating the reconstruction of the dissociated form, describes an improvement and simplification of the plate-model system devised by Born,‡ consisting in the adoption of transparent plates which are also much thinner than any hitherto used.

The apparatus required in the preparation of the new plates are an iron roller, 4 cm. in diameter and 30 cm. in length; a water bath for keeping the wax at a temperature of 60°; some strips of tin and brass from 0·2 to 5·0 mm. thick, and a large smooth lithographic stone.

In preparing the wax plates, a piece of the still warm wax is kneaded out in the hands as flat as possible, and having been placed between two leaves of parchment paper kept moistened with turpentine, is rolled out by means of the roller previously warmed. The thickness of the lamella is regulated by the choice of the metal strips placed along the sides of the paper. When a perfectly flat layer has been thus rolled out, the parchment paper is stripped off and the plate dried between filter papers. To the surface of these wax plates paper is made to adhere by means of gum, for which purpose flour is first rubbed into the plate, or by melting it in by means of a hot roller. The plates thus produced are of fair size, and from 1/3 to 1/4 mm. thick.

In preparing wax-paper plates to which the section-sketch is attached, a very similar procedure is carried out. This method is to be preferred to the former as a rule. One of the leaves of tracing paper is placed on the lithographic stone damped with turpentine. On the other side is laid a strip of metal, then the wax is spread over the surface and the second leaf of tracing paper having been adjusted, a flat lamina is produced by rolling as before with the heated roller. The thickness of these plates, paper and

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 192–5 (1 fig.).

† Ibid., pp. 179–92 (1 fig.)

‡ See this Journal, 1884, p. 634.

all, may not exceed 0·2 mm. Although firm in consistence, they are perfectly flexible, and are cut with sharp knives or scissors quite easily.

The author mentions also a mixture of gum-tragacanth, sugar and flour, as capable of being rolled out into very thin plates, but does not indicate the proportions of the ingredients.

(5) Staining and Injecting.

Rosanilin Nitrate for Goblet and Mucous Cells.*—Dr. J. H. List now uses a 0·0001 per cent. of rosanilin nitrate for goblet and mucous cells. Sections taken from 50 per cent. alcohol are overstained in the above fluid for ten to fifteen minutes. The superfluous stain is then extracted in absolute alcohol. The nuclear structure, as well as the reticulum of the cell, are well shown. After hardening in chrom-osmium-acetic acid, the chromatin of the nucleus comes out extremely well. The karyokinetic figures in epithelium are also well shown.

Absorption of Colouring Matters by Plants.†—Dr. W. Pfeffer, as previously recorded, ‡ has discovered that certain anilin colours are taken up by living cells and eventually assimilated. It is possible, therefore, that these dyes may be used to study the processes of absorption. If, for example, *Trianea bogotensis* is placed in a 0·001 to 0·002 per cent. solution of methylen-blue, the cells of the root-hairs will be found, in a few hours, to be stained a deep blue, while blue granules are discerned in the cells of the root-epidermis. The solution must not be too strong as a poisonous effect is produced on the plant. Assimilation of methylen-blue takes place when plants are left in a solution of one part methylen-blue to ten million parts of water. The pigment may be removed without damage to the plant by a 0·01 per cent. solution of citric acid.

Methyl-violet, cyanin, fuchsin, methyl-green, Bismarck brown, are taken up to some extent, nigrosin and anilin-blue not at all.

Methyl-violet and cyanin stain the cell-protoplasm without damaging the life of the cell, and the blue staining of the protoplasm by cyanin demonstrates also the alkalinity of the protoplasm.

Relation of Fatty Matter to the Receptivity of Staining in Micro-organisms.§—Dr. A. Gottstein after treating sections and cover-glass preparations with fat-dissolving reagents (heating the preparations with caustic potash in alcohol 2–5 per cent.), finds that tubercle bacilli, treated by the Ehrlich method, give the characteristic reaction, while smegma bacilli lose their acid-resisting property when manipulated in a similar manner. The author remarks that while ordinary fats lose their anilin staining after the action of an acid, lanolin, like cholesterin and certain fat-crystals (Celli's and Guarnieri's pseudo-bacilli) presents a similar resistance to acids, as do tubercle bacilli; hence smegma bacilli probably retain their staining capacity from the presence of a body analogous to lanolin.

Phloroglucin Test for Lignin.‖—Herr A. Tschirch finds the application of phloroglucin-hydrochloric acid a very useful test for the degree of lignification in wood; or, since the bark of most Angiosperms contains phloroglucin, hydrochloric acid alone may frequently be used. In this way it is shown that the bracheids are much more strongly lignified than the stereids in a "mixed ring," ¶ the former taking at once a dark-red

* Zeitschr. f. Wiss. Mikr., iii. (1886) p. 393.
† Bot. Ztg., xliv. (1886) pp. 114–25. ‡ See this Journal, 1886, p. 638.
§ Fortschr. d. Med., iv. (1886) p. 252.
‖ Pringsheim's Jahrb. f. Wiss. Bot., xvi. (1885) p. 325.
¶ Cf. this Journal, 1886, p. 1008.

stain, the latter becoming only gradually red. The staining by hydrochloric acid alone was very distinct in all woods examined except those of *Sambucus*, *Juglans*, and *Celutea*, in which it was but slight. In *Syringa* the bracheids were coloured blue-green by this reagent. Instead of hydrochloric acid, concentrated sulphuric acid may also be used, when the lignified cell-walls of plants which contain phloroglucin are coloured cherry-red. The red staining begins on the cambial side of the bast-bundles, showing that the chief seat of the phloroglucin is the leptome.

(6) Mounting, including Slides, Cells, Preservative Fluids, &c.

Medland's Portable Cabinet.—Mr. J. B. Medland's cabinet (figs. 29 and 30) is 11 in. × 5 in. × 3½ in., "only 2½ in. larger than the ordinary case holding one-half the number" of slides. It contains sixteen trays for nine objects each. Each slide is held at its ends by the projecting side-flap of the tray, which is kept down by the succeeding tray, and so on, the lid holding the whole firmly down. When open the lid and front fall

FIG. 29.

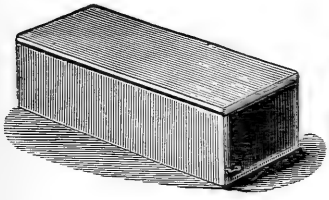
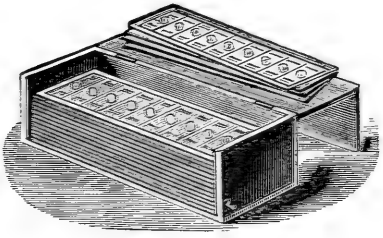


FIG. 30.



back, forming a stand or table upon which to place the trays, which are thus less liable to get displaced or upset than when placed among other apparatus or upon the work-table. The designer considers that the advantages of size, compactness, and the improvements over the ordinary case strongly recommend it to microscopists and others who may require to carry a number of objects in a small space with the least possible risk of damage.*

(8) Miscellaneous Matters.

Dissecting Pans.†—Mr. E. L. Mark recommends beeswax, rendered black with lampblack, as the best filling for dissecting pans, which should be made of glass. The most convenient size is 25 cm. by 15 cm., and about 5 cm. deep. The glass vessels are first heated in water, the temperature of which is gradually raised to near the boiling point; the hot wax is then poured in. If the surface become impaired the whole mass should be remelted, or the flame of a gas-jet be turned on to the surface for a short time.

Alling's Microscopical Records.—This book of forms is modelled after a plan suggested by Prof. S. H. Gage, modified to meet the wants of the general worker as well as the specialist by Mr. C. E. Alling.

* Cf. Engl. Mech., xliv. (1886) p. 363 (2 figs.); Sci.-Gossip, 1886, p. 258 (2 figs.); Nature, xxxv. (1886) p. 158.

† Amer. Natural., xx. (1886) p. 915.

Each page has (three times repeated) the following:—

Common Name	Method of Hardening
Scientific Name	Staining Agent
Locality obtained from	Clearing Agent
Obtained by	Mounting Medium
Mounted by	Date
Special Object of Preparation	Remarks

In addition to numbered spaces for 500 preparations, there are pages ruled for formulæ, so that they can be referred to by number and the repetition of the details with each object avoided. Also an index for cataloguing each preparation.

Gérard's 'Traité pratique de Micrographie.'*—This book, by Prof. R. Gérard, of the *École supérieure de pharmacie* at Paris, and formerly Director of the Microscopical Laboratory there, is one of the most extensive works on practical microscopy that has been published for some years. After a comparatively brief account of the Microscope and accessories, 325 pages are devoted to Botany, 48 to Zoology, and 64 to the application of the Microscope to clinical researches and hygiene. The illustrations include 279 woodcuts and 40 plates. The author gives throughout the work detailed statements of the technical processes which he has found most successful for each subject treated of.

Lee and Henneguy's 'Traité des Méthodes Techniques de l'Anatomie Microscopique.'†—Microscopists will remember the excellent 'Microtomist's Vade-Mecum' of Mr. A. B. Lee,‡ which collected and grouped in a convenient form the numerous and varied technical methods which had previously been scattered through a large number of serial publications. This work, whilst not strictly a translation of the 'Vade-Mecum,' is in the main founded upon it. Some chapters have been rewritten and extended, especially those relating to embryology, the cell, and the nervous centres. M. Henneguy claims that it includes "at once the grammar and the dictionary of microscopical technique." The translation was made by Mr. Lee and revised by M. Henneguy, and there is a commendatory preface by Prof. Ranvier.

(9) Bibliography.

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* Gérard, R., 'Traité pratique de Micrographie appliquée à la Botanique, à la Zoologie, à l'Hygiène et aux recherches cliniques,' iv. and 511 pp., 279 figs., and 40 pls., 8vo, Paris, 1887.

† Lee, A. B., and F. Henneguy, 'Traité des Méthodes techniques de l'Anatomie Microscopique, Histologie, Embryologie et Zoologie,' 8vo, Paris, 1887.

‡ See this Journal, 1885, p. 355.

Blood Plaques, Method of Studying. *The Microscope*, VI. (1886) p. 259.

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[Mr. Cathcart's directions for use.] *Micr. Bulletin* (*Queen's*), III. (1886) p. 4.

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Sect. II. Animal Histology. No. 5. The Uterus. (Plate V. Uterus of Rabbit × 30.) No. 6. Mammary Glands. (Plate VI. Mammary Gland of Cat during period of lactation × 250).
Sect. III. Pathological Histology. Nos. 5 and 6. Congestion of Kidney. (Plate V. ?) (Plate VI. Parenchymatous Nephritis).
Sect. IV. Popular Microscopical Studies. No. 5. The Sea Fans (*concld.*). (Plate V. T. S. Root of Dock × 30.) No. 6. Marine Algæ. (Plate VI. T.S. Fibrovascular Bundle of Maize, after Sachs, × 550.)

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[Sugar and lime—results "very disappointing."]
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iv. and 511 pp., 279 figs. and 40 pls., 8vo, Paris, 1887.

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[XII. Mounting media. XIII. Mounting in balsamic media. XIV. Mounting in aqueous media.]

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["Engine is about 'ten-fly power' and whirls the table at a very rapid rate."]

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Rocellin.
["Rocellin colours bone, connective tissue, glands, and epithelium cherry-red; gold or orange serves for fresh or alcoholic or chromic acid preparations. Bone is stained deep orange-red, cartilage, gold, connective tissue, reddish; especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels show on a gold ground; sections of skin give fine results. Preparations after washing and cleaning are best mounted in Canada balsam; oil of cloves is mostly used for clearing, but where the colours are very delicate, use oil of lavender or quite colourless oil of aniseed, as the yellow colour of the oil of cloves injures them."]
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viii. and 255 pp., 199 figs., 8vo, Jena, 1887.

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[Cf. 1886, p. 1075.] *Nature*, XXXV. (1886) p. 149.

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Amer. Mon. Micr. Journ., VII. (1886) pp. 203–4.

WHELPLEY, H. M.—**The Microscope in Pharmacy.** [*Post.*]
The Microscope, VI. (1886) p. 280.

WHITELEGGE, T.—**List of the Fresh-water Rhizopoda of N. S. Wales. I.**
["When gathering aquatic plants in search of any of the *unattached* forms of microscopic life, they should never be lifted entirely out of the water, but floated or pushed into a bottle with as little disturbance as possible. By adopting this method many more living forms will be obtained than would be the case if the plants were lifted altogether out of water." Also directions for preparing and mounting rotifers, infusoria, diatoms, desmids, &c., using 1 per cent. osmic acid.]
Journ. Linn. Soc. N. S. Wales, I. (1886) pp. 497–504.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th December, 1886, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 10th November 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
Lee, A. B., and F. Henneguy, Traité des Méthodes Techniques de l'Anatomie Microscopique, Histologie, Embryologie and Zoologie. Avec une préface de M. Ranvier. ix. and 488 pp. (8vo, Paris (1887) 1886)	*Mr. A. B. Lee.*
Microscopical Records. (4to, Rochester, N.Y., 1886)	*Mr. C. E. Alling.*
Electric (Incandescence) Lamp for the Microscope	*Mr. R. P. Hart Durkee.*
Seven Slides and 14 Specimens of American Fresh-water Sponges	*Mr. B. W. Thomas.*

Mr. Crisp read a letter received from Mr. Durkee, the designer of the electric lamp which was described and figured in the December number of the Journal (p. 1053), and there stated to have been "received anonymously from America." The letter explained that a full description had been sent by the same mail as the lamp, but it had miscarried, and the letter now to hand unfortunately did not arrive in time for the explanation to be inserted in the Journal with the description.

Mr. J. Mayall, jun., said that Mr. Crisp at their last meeting had pointed out that if Microscopes were to be made for every special purpose for which they could be used, there would be a large field open, and he had to introduce to their notice that evening another of this class. It had been designed to measure with great accuracy the divisions ruled upon diffraction-plates, which was about the severest test that could be applied to any method of dividing fine lines. The Microscope upon the table had been constructed with great care by Mr. Hilger after the designs of Sir Archibald Campbell, and was capable of executing measurements over a space of nearly 6 in. The diffraction-plates with which they had hitherto been familiar only occupied a space of about 1 in.; but he believed Sir Archibald had devised a ruling-machine which would be able to rule to 6 in. Mr. Mayall then described the instrument.

Mr. Mayall also exhibited and described a new form of heliostat, also made by Mr. Hilger, for use in solar photo-micrography, consisting of a plane mirror equatorially mounted and rotated by a clockwork movement, but also having a second mirror mounted upon a universal joint attached to the polar axis, so as to admit of motion in any direction. The pencil of sunlight reflected from the first mirror could, by means of the second, be directed in any desired direction, affording to the worker the very great advantage of being able to place his Microscope and camera in any position he pleased. When properly adjusted, with the polar axis parallel to that of the earth, the clockwork would enable the reflected beam to preserve the same direction for about six hours.

Mr. F. R. Cheshire exhibited and described an improved form of inoculating-needle for use in connection with bacterium culture-tubes. It was well known that the usual plan was to have a platinum wire fused into the end of a piece of glass rod, which served as a handle; needles of this kind had the merit of being easily made, and being also inexpensive. The one he exhibited cost rather more, but possessed sundry advantages which he thought might compensate for the extra outlay. It was mounted in a wooden handle having a square ferule, which prevented it from rolling when placed upon a surface which was not level; in this was inserted a piece of very small silver tube, at the end of which was the platinum wire. On the tube a circular disc of silver was fixed, which, when placed over the flame of a lamp, rapidly became hot, and communicated the heat to the needle—silver being a very good conductor of heat. The silver tube, being very much less thick than the glass rod, could more easily be introduced without coming into contact with the sides of the glass tube; but a much greater advantage than this also arose from its comparatively small size. The diameter of the ordinary culture-tubes was generally about 1/2 in., whilst that of the glass rods was about 1/4 in. On introducing the needle, therefore, the glass rod displaced a large quantity of air from the tube, and on its withdrawal the indraught would cause a quantity of outside air to pass in, and in this way impurities might be admitted, whereas, owing to the small size of the silver tube, the displacement of air by it was extremely small. He also thought that there might be less danger to the operator in the use of the new pattern, because the needle—perhaps charged with anthrax—could not come in contact with the table at all if laid down upon it. It would also be found more convenient to use it in cases where it was desired to separate the different forms in a colony. In order to keep these needles intact, they could readily be inserted into small pieces of glass tube, and when thus placed in a case they could be carried about with great facility.

Dr. E. M. Crookshank thought this kind of needle might be found very useful in some cases, but he fancied that most bacteriologists would prefer to have the ordinary kind with the platinum wire simply fixed in the end of a glass rod by holding over a Bunsen burner. As regarded the suggestion that there might be danger from anthrax getting upon the operating-table by the use of the ordinary glass rod, he pointed out that in practice it should be made a constant habit always to sterilize a needle after use by passing it at once through the flame without putting it down.

Prof. Bell called attention to some specimens exhibited of *Tænia nana*, the smallest of the human tapeworms, originally found by Bilharz in Egypt in 1850. Though extremely rare, it had the great advantage, to the physiologist at least (though perhaps not to the patient), of being found in considerable numbers. In the present instance the worms had been found in quantities in the duodenum of a girl aged seven years, at Bellegarde. The latest specimen met with was only 15 mm. long. Prof. Bell further referred to the observations of Leuckhart on the subject.

Mr. J. D. Hardy called attention to a statement by Dr. O. Zacharias in the October number of the Journal (p. 799) with reference to the desiccation of rotifers, and in which it was stated that they could never be revived after desiccation. He thought a protest should be entered against this, as it was within his knowledge that "revivification" had taken place over

and over again. He had frequently tried the experiment, and had found that when the dried mud was moistened the rotifers constantly revived.

Mr. Crisp, having read the paragraph referred to by Mr. Hardy, and also a paragraph bearing upon the subject from the December number of the Journal, p. 989, said that, as intimated in every number, the Society did not hold themselves responsible for the views of the authors of the papers noted, the object being to present a summary of them "as actually published." With regard to the merits of the question, if a few minutes after the moistening they found the adult forms moving about, it must be obvious that they could not have come from eggs, as stated by Dr. Zacharias. In 1860 a committee was appointed by the Société de Biologie of Paris, for the purpose of investigating the question. Brown-Séquard, Balbiani, Berthelot, Dareste, and Robin were members of this committee: Broca had charge of summarizing the results and drawing up the report of the committee. This report was published in 1860, and it remains one of the most accurate statements, and the most scientifically written papers on the subject. After a long series of experiments, the conclusions obtained were that rotifers can be brought back to life after having remained ninety days in a dry vacuum, and having been submitted to an influence of a thirty minutes' sojourn in an oven heated to 100° Celsius, that is, after having been as completely desiccated as can be. These are precise and accurate facts. The committee remarked, also, that the revivification of *Anguillulæ* may be effected at least twenty-eight years after desiccation; and following Leuwenhoeck's opinion, Broca believed that during desiccation vital phenomena were much reduced, but not wholly suspended.*

Prof. Stewart pointed out that a good deal must turn on what was meant by "desiccation." It was exceedingly difficult, under ordinary circumstances, to produce a condition of complete desiccation, and it was, therefore, very probable that in all cases of revivification there was sufficient moisture retained to preserve life.

Mr. A. D. Michael agreed in Prof. Stewart's view. That rotifers did apparently revive after desiccation was perfectly clear, and if a full-grown rotifer was revived in the manner stated, it was strange how any one could be found to suppose that it had come direct from the egg. He did not see any great difficulty in freely accepting the idea that the rotifers which revived had not really been absolutely desiccated. It was quite likely that they became covered with a coating of hardened mucus, which prevented them from altogether drying up.

Prof. Bell said that this explanation had usually been accepted as the real one when this subject perennially came to the front. The most curious part of Dr. Zacharias's paper, however, was that he did not in any way attempt to criticize the observations of his predecessors on the facts, but simply declared them to be fables, not inquiring at all into the conditions under which the revivals took place, so as to ascertain whether or not they were desiccated in the same sense in which his objects were when dried up in a granite basin. Prof. Bell also read from Dr. Hudson's and Mr. Gosse's 'Rotifera' the paragraphs relating to the desiccation of rotifers (pp. 95 and 96), in the course of which the observations of Mr. Davis, recorded in a paper read before the Society in 1873, were quoted.

Mr. R. T. Lewis said he remembered that on the occasion when Mr. Davis read his paper upon the subject, he brought to the meeting by way of illustration some grapes which he had coated with gelatin, and had afterwards exposed for many hours to the dry heat of a slow oven. On being cut

* Cf. Science, viii. (1886) pp. 208–9.

open in the room the fruit was found to be in a perfectly natural condition, showing that a gelatinous coating was competent to preserve the contained moisture from evaporation.

The President said he thought the question was practically settled so far as the judgment of microscopists was concerned.

Col. O'Hara's note on the dissimilarity of appearance of crystals of blood as examined by him and the illustrations in text-books was read by Prof. Bell.

Mr. P. H. Gosse's paper "On Twenty-four New Species of Rotifera" was read by Mr. Crisp, and two plates drawn by Mr. Gosse in illustration were handed round for inspection. (*Supra*, p. 1.)

The President said that those who had seen the drawings could hardly fail to be struck with the touch of them, especially when they considered the age of Mr. Gosse. In returning their thanks to the author, he could only say that they were proud—he used the word advisedly—to have the paper.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—*Tænia nana.*

Mr. T. Bolton:—*Stephanoceros Eichhornii.*

Mr. F. R. Cheshire:—Improved inoculating needle for Bacteria cultivation.

Mr. Crisp:—Amici Reflecting Microscope.

Mr. Hilger:—(1) Sir A. Campbell's Micrometer Microscope. (2) New form of Heliostat.

Mr. B. W. Thomas:—Slides and specimens of American Fresh-water Sponges.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. Edwin W. Alabone, M.D., Rev. N. Curnock, Antonio Mendoza, M.D., Albert Norris, and James Rae, M.D.

Meeting of 12th January, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 8th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Hay, W. Delisle, An Elementary Text-book of British Fungi, vi. and 238 pp., 59 pls. and 5 tables. (8vo, London, Swan, Sonnenschein, Lowry, & Co., 1887)	*The Publishers.*
Strasburger, E., Handbook of Practical Botany, for the Botanical Laboratory and Private Student. Edited from the German by W. Hillhouse, M.A., F.L.S., xxiv. and 425 pp. and 134 figs. (8vo, London, 1887)	,,
Photomicrographs (11) of Diatoms	*Dr. H. van Heurck.*

Mr. J. Mayall, jun., at the request of the President, directed the attention of the meeting to eleven photomicrographs which had been sent by Dr. Van Heurck, and which the latter thought showed results of exceptional merit. The one of *Amphipleura pellucida* by transmitted light was rather striking; it showed apparently two series of lines which were resolved into dots, and, so far as he was aware, this was the best of the kind he had yet seen. But Dr. Van Heurck did not say whether it was taken from a specimen taken from a dense medium or not, nor what was the actual magnification employed. In the pamphlet which accompanied the photographs it was stated that "no diffraction lines were visible whatever," but on examination, unless he was much mistaken, they had been painted out on the negative, so that Dr. Royston-Pigott, in his remarks upon this supposed fact, had made what the French called a *boulette*. If it was desired to give such photographs a real value the background should not be interfered with, and a small tablet should be left on which should be written the particulars as to magnification, mounting, and other data which it was essential to be in possession of in order to form any reliable opinion. In the case of *P. angulatum* he thought the photograph rather failed to show the results satisfactorily. It would have been better if only a small portion of the valve had been shown including the fracture. As regarded the longitudinal lines of *Amphipleura pellucida*, he had submitted them to Prof. Abbe, who said that as they appeared closer than the diffraction lines, that was a satisfactory demonstration of their existence in the object. As to the photograph of *P. angulatum*, in which a central spot was shown, all who were familiar with the object were aware that they could get the appearance of a central spot or not, according to how they looked at it. It was a question of change of focus. *Surirella gemma* he thought was not better shown than in Dr. Woodward's photographs. Then there were photographs of Nobert's lines, which were said to be those of the 18th and 19th bands; but here again there was nothing to enable one to identify them, or to say they were not the 14th and 15th bands.

The President, in thanking Mr. Mayall for his remarks, said it must be obvious to all that it would be of immense advantage to have the data by which alone they could form anything like a correct judgment as to the value of these, or indeed any other specimens of photomicrography. He thought also that it would be of advantage if they could have the opportunity of comparing these with those of Dr. Woodward.

Mr. J. Beck said he had not looked at any of the photographs except that of *Amphipleura*, but he should say that the manipulation which it had gone through had entirely destroyed its value.

Dr. Millar called attention to a photomicrograph of *P. angulatum* taken by M. Nachet in 1867, which was fully as good as the one now shown.

The President stated that it was proposed by the Council to fill up the vacancy in their list of Honorary Fellows by electing Mr. P. H. Gosse, F.R.S.

Mr. M. Pillischer exhibited his new "Kosmos" Microscope, which was described by Mr. J. Mayall, jun., as being made on the Continental model, with a short body and a direct-acting screw, the screws being bevelled off and the corners rounded. There was a very symmetrical foot, and the finish given to the instrument made it very nice to touch. The mirror was made with a neat swinging motion, and was of a somewhat shorter

focus than those generally in use, and it was claimed that, as regarded general finish and capability, it would compare favourably in economy of price with any others.

Mr. T. Charters White read a paper on "Tartar from Teeth of the Stone Age," numerous preparations being exhibited in illustration.

Mr. Crisp exhibited a cylinder of glass made at Jena, and described by Prof. Exner in the December number of the Journal, p. 1065. Though it had plane ends it acted as a concave lens, the reason being that it was of varying density from the centre to the circumference. It solved some of the questions which had been raised as to the images formed in an insect's eye. Mr. Crisp also explained Prof. Exner's method of preparing similar cylinders from celloidin and gelatin when the effect of convex lenses was obtained.

Prof. Bell said that in the interests of the particular branch of science to which he was devoted, he might mention that a little knowledge of histology by certain observers would have shown that the cornea was quite flat in the case of the crayfish, which had nevertheless managed to see very well for a good many years.

Mr. Crisp directed the attention of the meeting to enlargements on the blackboard of the figures of enormous Microscopes in Schott's 'Magia Naturalis,' 1657. These had long puzzled microscopists, who were at a loss to understand what could be the object of making Microscopes of the large size which was indicated by the comparison with the observers represented as looking through them. Having found in an old book sent to him by Prof. Abbe—Traber's 'Nervus Opticus,' 1690—what were undoubtedly meant for drawings of the same Microscopes, the mystery was solved; for if Schott's figures of whole-length men were rubbed out and single eyes were substituted for them, as Traber did in his drawings, the scale of the Microscope represented was of course strikingly altered, and it was seen that they were small hand Microscopes after all. Schott's draughtsman probably had too much of an artistic eye. (*Supra*, p. 148.)

Mr. J. B. Medland exhibited and described his new portable cabinet for microscopic slides, in which twelve dozen slides were packed in a space 11 in. × 5 in. × 3½ in. (*Supra*, p. 173.)

The President thought this was a very simple and practical mode of making a compact cabinet, which would commend itself at once to all who examined it.

Mr. Crisp exhibited Stein's Electric Microscope. (See this Journal, 1885, p. 303).

Mr. A. W. Bennett gave a *résumé* of his paper "On Fresh-water Algæ (including Chlorophyllaceous Protophyta) of North Cornwall," with descriptions of six new species, illustrated by coloured diagrams. (*Supra*, p. 8.)

The President said they must all feel indebted to Mr. Bennett for his very interesting communication, and they could not fail to note how very much pleasure there must have been added to a holiday in the case of one who had made himself so thoroughly master of this subject. He thought this paper was full of encouragement to others, because every young student

had the ditches and ponds open to him, and there was the opportunity for all to add to their physiological knowledge of this interesting and beautiful group.

Mr. J. Mayall, jun., gave a very interesting account of a recent visit to Jena, which he said Mr. Crisp had aptly termed the "Mecca of microscopists." There he had been afforded every facility for examining all the processes of manufacture as carried on in the factories of Dr. Zeiss. He also described his interviews with Prof. Abbe and the way in which they had together tested numerous objectives which he had taken with him for comparison. (A full description will be printed *post.*)

The President said he thought the Fellows would agree that their Society was sufficiently mature to be entitled to get the highest possible perfection obtainable with respect to its apparatus and appliances, so that whatever would contribute to the attainment of any increase in this perfection could not fail to be of the greatest interest to them. From what they had just heard, he felt sure that Mr. Mayall's visit to Jena had not been in vain; his communications would no doubt give rise to an amount of interest and attention which would be certain to bear fruit at no distant date, in the form of still further increase in the perfection of the very admirable work which they were already so familiar with.

Dr. A. C. Stokes's paper "On some new American Fresh-water Infusoria" was read by Prof. Bell. (*Supra*, p. 35.)

The List of Nominations for Council and Officers for election at the Anniversary Meeting was read by Mr. Crisp.

Mr. Hembry and **Mr. Vesey** were elected Auditors of the Treasurer's Accounts.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—Ova of Trout.

Mr. Crisp:—(1) Stein's Electric Microscope. (2) Glass cylinder with plane ends acting as a lens.

Dr. H. Van Heurck:—Eleven Photo-micrographs of Diatoms.

Mr. Medland:—Portable Slide-cabinet.

Mr. M. Pillischer:—"Kosmos" Microscope.

Mr. T. C. White:—Slides illustrating his paper on "Tartar from the Teeth of the Stone Age."

New Fellows:—The following were elected *Ordinary* Fellows:—Rev. George Bailey, Messrs. Ferdinand Coles, Sydney A. M. Copeman, M.A., M.B., Griffith Evans, M.D., F. T. Law, Reginald T. G. Nevins, and H. Virtue Tebbs.

February, April, June, August, October, and December.

1887. Part 2. APRIL. { 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

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

JOHN MAYALL, JUN., F.Z.S.,

R. G. HEBB, M.A., M.D. (*Cantab.*),

AND

J. ARTHUR THOMSON, M.A., *Lecturer on Zoology in the School of Medicine, Edinburgh,*

FELLOWS OF THE SOCIETY.

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β. Histology.

γ. General.

B. INVERTEBRATA.

Mollusca.

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110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
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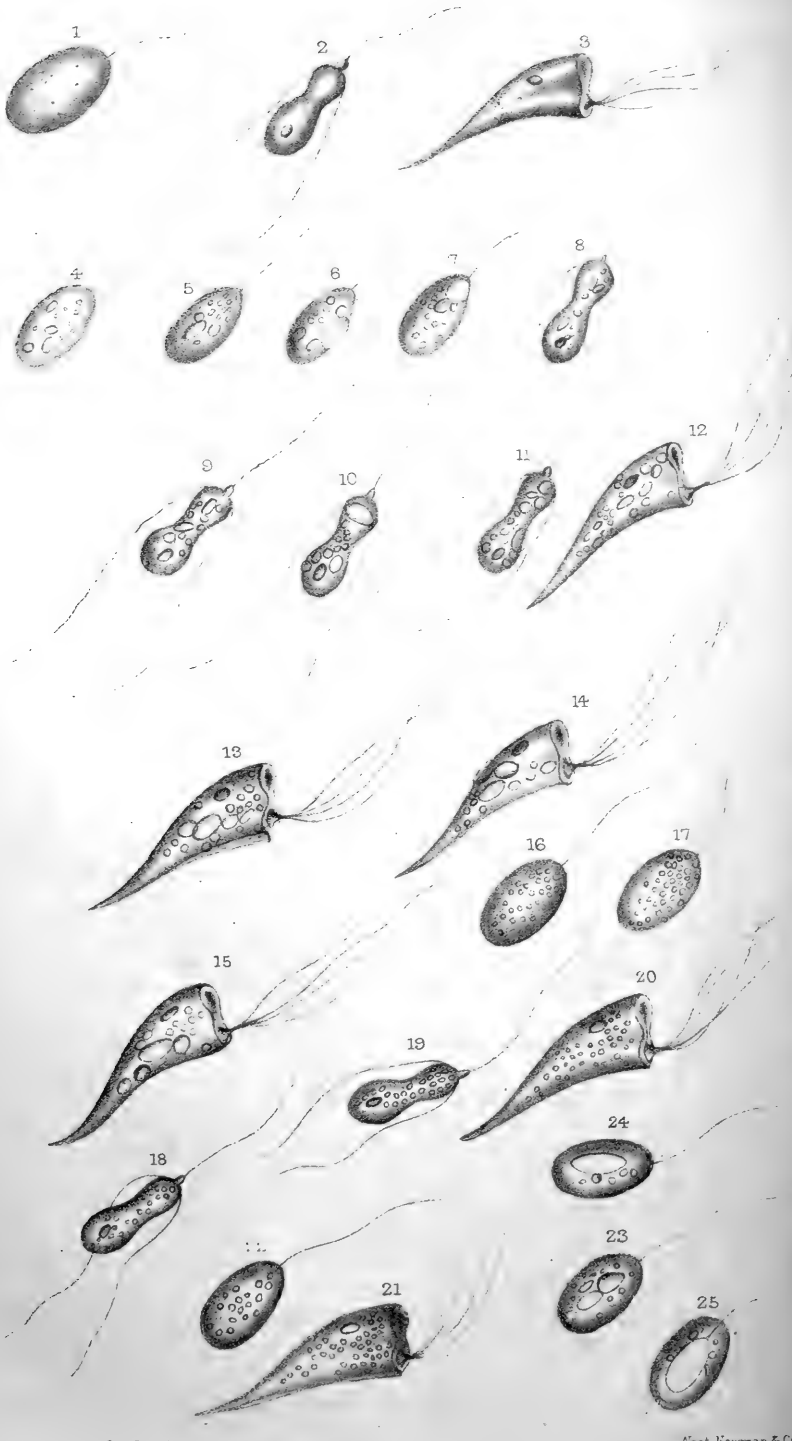

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Illustrating the President's Address.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1887.

TRANSACTIONS OF THE SOCIETY.

V.—*The President's Address.*

By the Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., &c.

(*Annual Meeting, 9th February*, 1887.)

Plate VI.

In proceeding to fulfil the honourable duty that by your courtesy devolves upon me, I purpose in the main to follow the line I have taken in preceding years. I congratulate the Society on its work, and on its steady influence in promoting progressive improvements in the optical and mechanical construction of the Microscope, devoid of all prejudice as to how, or from whence such improvements may come. And whilst happily it is not of necessity a President's duty to pass in cursory review the microscopical work of the year, there are times when it may be well for him to review the points of improvement that have been made in the instrument itself.

For the past twenty years I have had an increasing interest in the continuous improvement of the optical appliances of our instrument; an interest which, from the first, applied not only to objectives, but also to eye-pieces and condensers, which consecutive calculation, thought, and experience have shown to have a correlated importance.

Eighteen years ago I had by practice made myself fairly master of a 1/25 in. objective of that period, made by Powell and Lealand. I still possess that lens, and it is as good a lens of its class as they ever constructed.

Soon after I became equally familiar with a 1/50 in. of the same class by the same makers.

By saying that I became master of these lenses, I mean that I discovered exhaustively what they would and what they would not do. By this I learned definitely what I wanted in lenses if I could get it; and to get that has been my unceasing endeavour until now. And certainly the quest has not been vain. And my method has been to examine impartially, and possess myself of, English, Continental, or American lenses, whenever they have showed any capacity for doing best what my work proved to me required to be done.

I know that in estimating the quality of a lens by the class of image it affords of certain test objects well known to us, a certain amount of empiricism must take place. We do not absolutely know the image it ought to present. But this applies only within very narrow limits.

Take the Podura scale: I can give you an image of it with my 1/25 in. and 1/50 in. of twenty years ago. What I, in common with most microscopists, considered then the best result, the most sharp, clear, and delicately defined image, with those lenses, I can get now; but with those objectives, nothing better.

But the elements—the essential features that constituted the quality of beauty in that image—are the very elements, the actual features, that every admitted improvement in our object-glasses has brought out more perfectly. So that if I now put, say the Podura scale under my old dry 1/25 in. objective, and beside it another precisely similar scale under a new homogeneous 1/20 in. objective of N.A. 1·5, the very qualities of the image which I, and experienced microscopists generally, thought the best twenty years ago, are incomparably transcended in beauty and perfectness now.

But that is not, and has not been, my only or my chief test. It has been one eminently practical so far as my own work went—at least for some years.

Up to ten years ago, although I had spent weeks in patient effort, no lens that I possessed or that was within my reach could be made to reveal the flagella of *Bacterium termo*. The flagella of many minute monads, and of such bacterial forms as *Spirillum volutans*, and even *Bacterium lineola*, I could demonstrate; though some of them with difficulty, but not a trace of those of *B. termo*. But near that time Powell and Lealand produced a battery of immersion lenses on a new formula, and of much relative excellence; and with these lenses the flagella of *B. termo* were brought within the range of sight.

Since that time, that has been a good lens to me, in proportion to the greater or less ease and perfection with which it has revealed this delicate fibre. And let me say, that such lenses as do this are those that always, without fail, give us the best ideal image of Podura scales and other tests. You will pardon me, I trust, for this amount of personal reference, since it will give a greater relevancy to what will follow.

Improvements of great optical importance have been made during the last few years. The manufacture of homogeneous lenses by Messrs. Powell and Lealand, gave us the opportunity which we could not have with foreign makers, of urging certain modifications. The addition of the correction collar was a minor, but still important item. But the great point was the increase of the N.A. These makers have shown themselves most anxious, and have spared no efforts to reach the highest aperture yet attained.

Advancing, say, from N.A. 1·25 they attained to 1·38 in such powers as the 1/25 in. and the 1/50 in.; subsequently to 1·47 in a 1/8 and 1/12 in. objectives, and finding these from my working point of view of such supreme gain, I urged them still on; and was ultimately rewarded by the possession of a 1/6 in., N.A. 1·5, followed by a 1/12 and a 1/20 in. foci of the same great aperture. From each of these I obtained special advantages over all equal powers, but with lower apertures, within my reach.

A question frequently asked may be asked again, in what way these last increments of aperture aid us. The practical answer is not difficult.

Speaking from observation I may say that all the objectives I have employed for the most critical work, fail to produce images by the extreme marginal zone of the aperture. It is the judgment of competent judges that it will be fair to roughly estimate this defective outermost zone at ten per cent., so that from the total measurement of the aperture by Prof. Abbe's method, I find that in practice this amount may be deducted, as of very little service, in all apertures beyond about 1·3; hence, to be able to utilize fully any given aperture beyond 1·3, it is practically necessary that the measurement by means of Abbe's apertometer, should be about ten per cent. higher.

But a further advantage of great numerical aperture is that, other things being equal, we can utilize with excellent results deeper eye-pieces.

I have long realized the advantage, with finely corrected objectives, of a far larger series of eye-pieces than the catalogues provide. Messrs. Powell and Lealand several years ago made me one or more eye-pieces between each of their deeper eye-pieces of standard catalogued focus; and they certainly, within the limit of excellence, beyond which greater eye-piece power cannot be employed, bring out to far greater perfection the qualities of any high class object-glass.

But we have had announced to us an improvement of the optical arrangement of the Microscope, based upon an important and fundamental change in the media employed in the construction of object-glasses and eye-pieces; it will be known that I refer to the system of apochromatic object-glasses and compensating eye-pieces devised by Prof. Abbe, and under his auspices, carried out by Messrs. Zeiss of Jena.

The aim of the construction of these new objectives and eye-pieces has been to provide a higher degree of achromatism than could be reached by the old media; the new kinds of glass produced at the Jena optical glass works, under the superintendance of Dr. Schott and Prof. Abbe, can be so combined in the construction of an object-glass, as to achromatize not only the essential portion of the primary spectrum, but also to a great extent the secondary spectrum, leaving only small residuals of the tertiary order still visible under certain test conditions. The final elements of correction are supplied by "compensating" eye-pieces of special construction, designed to correct what Dr. Abbe refers to as "the differences in the amplification of the image for the various colours . . . . formed by the objective outside the axis, which cannot be corrected in the objective itself."

The first trials of these new optical combinations made in Germany evoked unstinted praise; and those who, like myself, desired nothing so much as real improvement, awaited their arrival in England with eager and even anxious curiosity.

The first that came to this country came to Mr. Frank Crisp, and by his courtesy this lens, an apochromatic of 1/8 in. focus, was placed in my hands. I subjected it to comparison, in succession, with my complete set of high powers, including those of N.A. 1·5, and upon tests, and by methods which I have indicated.

It will be well understood that the high excellence and great aperture of my three latest object-glasses, to say nothing of the very

high quality of their immediate predecessors, would have given a very elevated standard of comparison; and the result was that, after most exhaustive and critical investigation with the same tests, the potentiality of the system represented by the apochromatic lens, most powerfully and hopefully impressed me. I felt, in fact, that the lens itself was of great merit. But withal, by the standard of test the latest of my lenses enabled me to employ, I felt that its merits had been over-estimated.

It is quite true that on some of my delicate test objects, the images shown by the apochromatic lens, in combination with the "compensating" eye-pieces, appeared to advantage, when compared with my lenses combined with the ordinary eye-pieces; but when I tried my own various powers with the same compensating eye-pieces, I am constrained to say, that no real advantage over my latest lenses could be discovered. My judgment therefore was most favourable as to the immense advantage of the eye-pieces, and of the possibilities that lay in the entire system, rather than in this special apochromatic object-glass taken by itself; and although pressed again and again by the editors of journals to give a public expression of my judgment, I steadily declined, feeling that it was not, and could not at that time be exhaustive.

Later, an opportunity was courteously afforded me, by the makers, to examine a complete series of these object-glasses, from 1 in. to 1/8 in. focus, and with eye-pieces fitted for English stands.

In the examination of these objectives and their systems of eye-pieces, I spared no pains to be exhaustive and impartial. I *desired* to find the evidence of progression in optical excellence for which I am always in search, and the excellence of the 1 in. greatly impressed me; but I failed to realize my high hopes in the behaviour of the higher powers. The result, however, of a most critical examination was to very greatly strengthen my conviction of the value of the optical system which these lenses represented, and above all, of the excellence of the actually new resource provided for us by the compensating eye-pieces.

In what I have here said I must again remind you that the comparison of Zeiss's apochromatic object-glasses was with a group of object-glasses the most carefully made, most excellently corrected, and with the widest numerical apertures, of any object-glasses that had ever passed through my hands, based on the old system of correction. But with this understanding, it appears to me a responsibility that I must not evade to state the facts at this crisis in the development of object-glasses. And I do this with the more confidence, that, as I have already informed you, Mr. Mayall, wholly independently of me, examined this set of objectives and eye-pieces, and we each recorded separately in writing our judgments at the time of examination; and I subsequently found that our resulting judgments were almost identical.

During this time samples of the new optical glass had reached the English opticians, and Messrs. Powell and Lealand, in a relatively brief time, and on a formula of their own, made an apochromatic 1/12 in. object-glass and eye-pieces, constructed on the plan devised by Abbe. By the wise advice of Mr. Mayall this was exhibited at our November meeting. My high opinion of that lens and its compensating system of

eye-pieces I at that meeting expressed; and need only add that since I have become the possessor of a second object-glass of precisely similar construction and power made by this firm, I am much strengthened in the opinion I gave.

We all appreciate the splendid services rendered to Microscopy by Prof. Abbe; and it was a happy expression of that appreciation that led Mr. Mayall to propose a visit to Jena, with his Microscope and such object-glasses as he thought would worthily represent the standpoint we had now reached in England.

I understand that Prof. Abbe greatly desired this, wishing to possess the fullest information as to our methods of testing object-glasses, and to be permitted to examine our best optical work.

I need hardly say that it was a source of great pleasure to me to place at Mr. Mayall's disposal all the lenses and apparatus I possessed that would serve him: for it was in the highest interests of the microscopy of the world that so great a leader in its recent progress should see the effects of his teaching and practice as evidenced by our latest object-glasses, and especially by the new apochromatic 1/12 by Powell and Lealand, with its system of compensating eye-pieces.

Mr. Mayall has told us the story of his visit; of his kindly reception; of the earnest and repeated trials of the object-glasses he was able to submit to Prof. Abbe, and of the frank appreciation expressed by Prof. Abbe of the English object-glasses. This comparison will, in my judgment, "make history" for the future of our instrument. It will react here and in Germany. Prof. Abbe's splendid powers are more than ever concentrated on the work of touching a higher perfection in object-glasses, and he knows that every improvement initiated in Jena will be watched by keen eyes in England; and he has evidence, which will be as welcome to him as his work is to us, that we are not likely to neglect any point of excellence, provided only we can be made to see it as such.

I understand that Dr. Zeiss admits that the formulæ on which his apochromatic objectives are constructed involve far greater technical difficulties than were met with in the older formulæ; and this is evidenced by the great number of separate lenses combined in the construction.

Now it has long been my judgment, and a judgment that has been confirmed by men of large practical experience, that errors of technical execution, when present, are shown at once by deep eye-pieces: with an object of regular structure, whose image fills the field of the eye-piece, the experienced eye readily detects a want of sharpness. I am bound to say that the apochromatics from Jena did not impress me by this test as having accuracy of technical execution equal to the object-glasses with which they were compared.

On the other hand, I find that with the new apochromatic made by Powell and Lealand, I can employ advantageously, deeper eye-pieces than I had ever used before.

Now there is a less number of separate lenses in the London objective; and whether this superiority is due to the less number of lenses, or to other causes, I may not determine. I refrain from details con-

cerning the comparisons I, amongst others, made of the lower-power apochromatics of Zeiss, further than to remark that in my judgment too much has been sacrificed to the object of enabling the observer to employ very thick cover-glasses. This is, no doubt, a convenience; but if, as in Zeiss's 1/4 in. and 1/6 in., the choice lies between object-glasses that cannot be used for covered and uncovered objects, and object-glasses that, with a moderate range of thickness for cover-glass, provide that facility, the latter appear to me, from a practical point of view, to be the better.

I note with interest that Powell and Lealand have made an achromatic oil-immersion condenser of N.A. 1·4, and will probably be able to increase the aperture to 1·5 in proportion as thinner glass is used to mount objects upon. The mechanical part of this instrument had, when it first reached me, a very neat form, but was difficult of manipulating, and this involving, as it did, alteration, has prevented me from really testing its merits. But I have just received it, with a mechanical modification I suggested well carried out, and I have little doubt but I shall realize now its optical excellence.

On the whole, then, we may rejoice in the fact that a distinct advance has been made in the optics of the Microscope; and the more so from a conviction that there lies considerable potentiality still in the sources from which the amount of progress made has resulted.

At the time that I was engaged in preparing to write the Address I had the honour to give to this Society last year, I was for some time in a state of mental indecision as to which of two subjects I should take, the one I selected, or another that had occupied my attention and secured my interest for between six and seven consecutive years.

But just a short time before, an accident, which no foresight could have guarded against, happened to the apparatus employed, which occurring in my absence, brought to an abrupt termination the consecutive observations of nearly seven years.

This of course greatly depressed me; for although the observations made were in themselves, and so far as they went, most interesting, they were incomplete; for the experimental conditions I had set up, and to which I will presently refer, must have ended fatally to the organisms under experiment at some point; and that point had not been reached.

As a consequence, I, under the influence of immediate depression, came to the conclusion that I must abandon the whole matter; and I gave a brief and rough outline of what I had tried to do, to a local Society and endeavoured to forget it, choosing the subject I had the pleasure of bringing before you last year as my Annual Address.

But soon I began to look carefully over my records, and to see that what had been done was of real interest; and I found that going entirely over the ground again, with enlarged knowledge and experience, might after all be a benefit. I therefore restored, renewed, and added to my apparatus, recommenced the observations, and for several months now my thermostat has been successfully at work, repeating the observations of past years.

I have determined that a record of the former series of observations,

studied in detail, presents results that may not be without interest to this Society, even in an Annual Address.

The observations I refer to were made with a view to discovering whether it was possible by change of environment, in minute life-forms, whose life-cycle was relatively soon completed, to superinduce changes of an adaptive character, if the observations extended over a sufficiently long period.

For such observations it is manifest that the lowest forms of the infusoria offer suitable subjects.

In themselves and taken by themselves, these organisms, under such experiment must afford instruction, if we can obtain results. But it is also of interest to remember that the inference that the higher and more complex animals and plants are vast aggregations of cells differently endowed in different parts of the organism, but all functionally united and correlated to secure the life of the living thing they compose, is an admitted fact in biology. This must add, indirectly, a further interest to the subject.

Few biologists need any direct demonstration to convince them of the truth of Darwin's great law of the origin of species. It underlies as a necessity all our widest and deepest biological knowledge. Concurrent adaptation to concurrent changes of environment is in fact so apparent now, that we wonder, often, why it was not earlier seen.

Nevertheless, if it be possible to look upon the progress of changes in minute living organisms, superinduced by elected changes of environment, however simple, and which results in morphological and physiological adaptations and survivals, it cannot be other than a gain both to philosophical and practical biology.

Before actually setting up a definite line of procedure, I spent a year and a half in tentative experiment; and very soon found that the best subjects for my research would be the monad forms I had become so familiar with, and the phases of whose life-history I knew; and that the best and most amenable agent I could use for altering slowly and cumulatively the environment, was heat.

After the year and a half of trial I obtained certain very definite results, which it appeared to me pointed to the possibility of obtaining others of a far higher meaning and value, if the methods of conducting the inquiry were carefully devised, and for an indefinite time continuously operative.

At this time I was closely tied to a provincial town, and had little opportunity for consultation with leading men of science; but amongst the few who influenced my determination was the late Chas. Darwin. He had shown great interest, and given me great encouragement in prosecuting the life-histories; and in correspondence, amongst other things, I gave him details of the imperfect but still interesting results I had obtained by thermal experiments on these forms, and the preparations I was making for systematic inquiry in that direction. After words all too generous, he said in his reply, which was dated July 2nd, 1878, "I did not know that you were attending to the mutation of the lower organisms under changed conditions of life; and your results, I have no doubt, will be extremely curious and valuable. The fact

which you mention about their being adapted to certain temperatures, but becoming gradually accustomed to much higher ones, is very remarkable. It explains the existence of algæ in hot springs. How extremely interesting an examination under high powers on the spot, of the mud of such springs would be."

Shortly after this I brought my tentative and experimental work to a close, and commenced the course of observations I shall here detail.

I need not remind you that all biological changes must be slow. Variations are constant, of that there can be no doubt; and under domestication they are very palpably increased and conserved.

But the smallness of every variation, as a rule, and the relative fewness of the generations that come into existence, even of prolific animals and plants during the working life of an observer, to say nothing of the difficulties that would present themselves in other ways, make anything like individual observation on visible forms under experiment almost impossible and hopeless.

Save for the useful and remarkable modifications effected in animals and plants under domestication, the great process of biological progression, made clear to us by Darwin, is essentially a secular one, and is comparable to the vast secular processes of astronomy, such as the precession of the equinoxes; which, although we have observed but a minute fraction of the complete cycle of movement, leaves us as certain of what that cycle is as though we had traversed its immense circumference under continuous observation.

But this very fact, as in astronomy, so in biology, makes any observed facts that may come within our reach, or be possible to our laboratories, of even enhanced value.

Now in the Infusoria—say the septic organisms—the cycle of life is so relatively short, and the generations succeed each other so rapidly, while the successive progenies can be so easily observed, that if we can devise apparatus and conditions which will enable us to institute slow changes of environment, we should be able to observe critically how far changes in the organisms led to responsive adaptations and successive survival. At the same time it would be possible to closely investigate the condition and appearance of the organisms themselves.

To know the living forms under experiment, through all the changes of their life-cycle, was therefore important; and I chose such of the monads whose life-history I had worked out, as were most easily obtainable and most abundant.

Every ingenious mind will have its own suggestion for the modification of the environment of such organisms; but after the tentative work I had already done, and in view of the fact that at that time the question of the influence of heat on this whole series of putrefactive organisms was being eagerly discussed, I determined finally to make cumulative increments of heat the means of adverse environment; I wanted therefore a delicate thermostat, that should be capable of alteration at will to the temperature at which it should again become static.

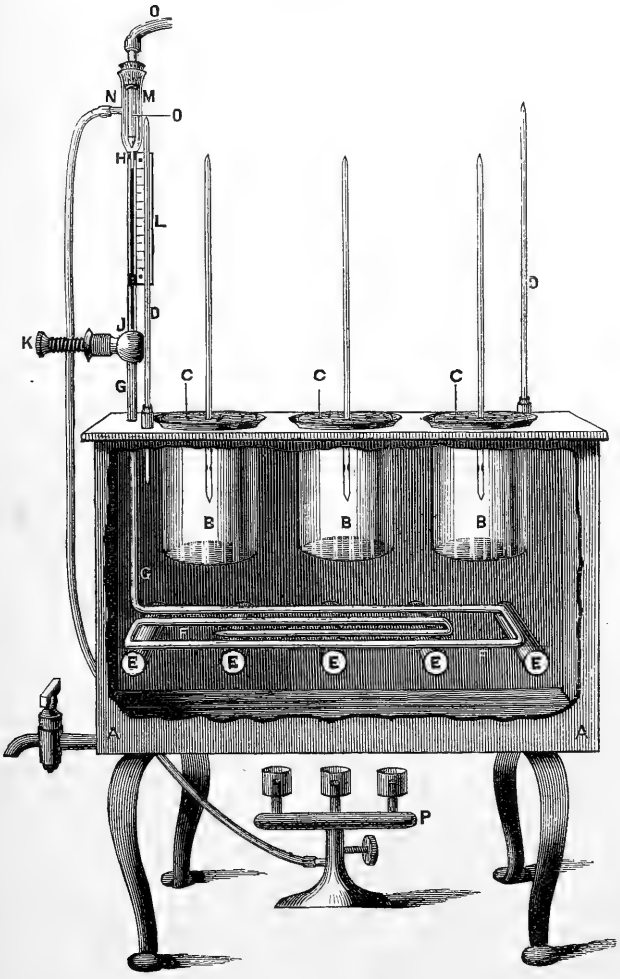
After I had made a considerable number of preliminary experiments, and had been aided by suggestions, especially from my friend Mr. Joseph

Swan, my ideas were carried out by Messrs. Elliott Bros., of this city, who, early in 1879, furnished me with an apparatus that completely met my want.

The ingenious device of Prof. Schäfer for maintaining a constant temperature in a warm stage for the Microscope, published in 1874,* formed the foundation of my arrangement.

A drawing of the apparatus is given in fig. 31. A A is a large

Fig. 31.



strong copper vessel with a jacket of felt, containing water. In the drawing the nearest side is supposed to be removed to show the interior. B B B are three vessels containing the putrefactive fluids and organisms.

* Quart. Journ. Micr. Sci., xiv. (1874) p. 394.

These are of glass and are immersed in the water. In the upper rims of these vessels, which are outside the copper container, C C C are loosely fitting cork tops, in the centre of which delicate thermometers are fixed, so as to have their bulbs plunged into the putrefactive fluid. D D are two thermometers of a similar kind placed in the water of the copper vessel to register its temperature. E E E E E are copper tubes fixed across the copper vessel, some distance from the bottom, to form a firm support for the glass tube "gridiron" F F; this is continuous with the tube G G, and is filled, from somewhere near H, throughout all its length, with about ten pounds of mercury. The bulb J is also full of mercury, and K is a steel screw plunger, which by being screwed in or out can raise or lower the column of mercury above it. L is an ivory index of the height of the mercury. M is a chamber larger than the general tube G, and has a rectangular arm N; into M is fixed by a cork, air-tight, a smaller tube O; this is in direct communication with the gasometer. In the bottom of this tube is fixed a tube of platinum, which "wets" with mercury, making a sort of contact, but not an amalgam.

From the tube N proceeds all the gas that supplies the burner P. The gas therefore, coming in at O O, finds its way out between the bottom of the tube O, and the top of the mercury, into the tube H, and so to the burner.

When the right point of temperature is attained, the steel plunger K is screwed in until the mercury is close to contact with the platinum; and by about an hour or so of watching and manipulation the temperature is made static at the point required, for if the heat become slightly higher than it should be, the mercury, by touching the platinum, stops the supply of gas; and the gas would go out, but that a very small hole is pierced in the platinum of the tube O opposite H, which, when the platinum and mercury are in contact, sends enough gas to the burners to keep up a flame in each, of more or less diminished intensity as the nature of the case requires. Hence, with a smaller heating power in the burners, the temperature falls very slightly; and so does the column of mercury: by this means the amount of gas sent to the burner is increased, the heat is again raised a minute fraction, and thus, within a quarter of a degree Fahr., the fluids may be kept at a fixed temperature, which is none the less variable at will.

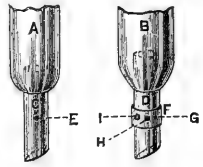
Two essentials are involved in the delicate working of this instrument; the first, especially with the lower grades of temperature, is a room which shall be of a constantly even temperature; and second, gas for consumption at an unchanging pressure.

This latter is now so comparatively easy of accomplishment, by several useful instruments, such as Moitessier's gas pressure regulator, that it is needless to burden you with details of the less elegant and more laborious method which I employed in the earlier days. They were, however, quite efficient, and I have now two thermostats at work on this matter in which the variation is less than a sixth of a degree Fahr. in twenty-four hours.

For greater accuracy in action it is well to have several small Bunsen burners grouped, each with a separate stop tap, and the whole capable of

being racked up and down by a milled head. We thus control the heat accurately. The flames should be guarded by small glass cylinders. Moreover, for low temperatures it is needful to be able to control the amount of gas which shall be the minimum amount when the mercury has risen to block out the main supply; this I have accomplished by means of a collar of diaphragms seen in figs. 32 and 33. In A the end of the glass tube bringing the gas into the instrument is shown, viz. O of fig. 31. C of fig. 32 is the platinum tube which makes contact with the mercury; it is best for its end to be at an angle; it cuts the gas off more gradually. E is the aperture through which gas goes out when the tube is blocked with mercury. Now it is needful to have the amount of this under control. This is done by a collar of diaphragms, seen at F in B, fig. 33, which is placed upon the platinum tube D. There are different sized apertures in this collar, as G, H, I, and the hole E in A being made as large as the largest in the collar, and the collar revolving gas-tight, we can use at will a larger or a smaller aperture.

Fig. 32. Fig. 33.



By a simple arrangement, which I have already for another purpose exhibited and explained to this Society,* I constructed a warm stage fitted to a suitable Microscope, which was attached to the large water vessel of the thermostat, by tubes, so that the water in the vessel was kept in constant circulation in the stage, and by this means I could examine the organisms in the glass vessels at the temperature at which they were living.

I confined my attention to three well-known organisms, whose life-cycles I fully understood, and had completely followed. They were those which Mr. Saville Kent has named *Tetramitus rostratus*, *Monas Dallingeri*, and *D. Drysdali*. Of course, beyond these there were a large number of putrefactive forms in great abundance, such as *Bacterium termo*, *B. lineola*, *Spirillum volutans*, and other forms of monads. But my attention was confined wholly to the three specified organisms.

I resolved on using very minute increments of heat very slowly. I commenced at a normal temperature of 60° Fahr., and the first four months were employed in raising the temperature 10°. This, by control experiments, I found to be quite unnecessary in itself, for even a relatively very rapid rise from 60° to 70° Fahr. will quicken the multiplying power of these organisms.

But also, by rough control experiments, I learned that the more slowly and regularly the first increments of heat, between 60° and 70°, were superimposed, the greater safety was there in slow progressive advance.

But no discoverable change took place during this time. The normal processes went on in a normal way. The organisms were extremely abundant; fission occupied the same time, and occurred at the same intervals; while the spore-sacs, resulting from the blending of two forms, were as we have always seen and described them.

At every successive access of heat I made very critical examinations, not only of the morphological details, but also of the condition of the

* Cf. *infra*, p. 317.

sarcode of the body. But I discovered absolutely no noticeable divergence from the normal state.

In the first two months I elevated the temperature six degrees; and during the next two months two degrees per month.

It is extremely difficult to judge of such a matter, but there appeared to me evidence that from the 68° to the 70° there was possibly a quickened and enlarged productiveness. But there was no way of demonstrating this; and if this were so, when at the expiration of another month I raised the temperature a degree, I had reason to suspect adverse influence on the organisms; and this became manifest two months after, when the temperature was raised to 73°. There was a great falling off in members in the field. From whatever part of the containing vessel a minute speck was taken for examination, it was palpable without any exact numerical estimate that each of the organisms were fewer in number, while many died under examination upon the warm stage.

On submitting them to critical examination I could discover no change, save that even the healthy and active ones were not quite so rigorous as in earlier stages.

This was the state of things immediately upon elevating the temperature to the point named. And this continued for the next few days, and I began to contemplate a move backwards of as small a portion of a degree as I could accomplish; but the diminution was not continuous after a week, and I left the temperature untouched. It was static at this point for two months, and during this time the vital vigour and all the vital activities of the organisms were regained. I then ventured to raise the temperature to 74°; at the end of twelve hours there was a visibly adverse influence, but not so marked as before, nor so long continued. In four days there was a complete restoration of the vigorous condition.

At this point I left it static for six weeks and then commenced to try to raise the thermal point; the greatest caution had to be used, for although no immediate effect was visible in the course of a day, or at farthest two days, if an excessive or too hasty increment of heat had been added torpor became everywhere visible, and a total collapse was threatened. But in the course of five months I advanced from 74° to 78°.

But here a critical point was manifestly reached, for they began in large numbers to succumb; and it was only by altering the temperature backwards and forwards between 77° and 78° for several weeks, that I was able to get the three forms under examination to rest in fairly healthy vigour at 78°.

Beyond this point I could not elevate the heat even half a degree without very visible evil influence, for eight months. During that time repeated attempts were made, but with what at first threatened to be fatal results; only the longer they remained at 78° the less injured were they by the heat increment.

During this time I watched with all the care I could command the processes of sporing, growth and fission, which presented no unusual feature; and I also, with all the best aids in light and lenses which I could get, searched for any modifications in the sarcode.

For the first two months nothing that I could really be sure of was visible to indicate such change; but *M. Dallingeri* has the peculiarity of being almost entirely, in the normal state, free from vacuoles in the sarcode. I had noted and drawn the other forms several times much more vacuolated than was usual; but I now, at between two and three months after 78° had been reached, observed frequently that *T. rostratus* and *D. Drysdali* were also vacuolated; and in the course of a month this was not only abundant, but far more the rule than the exception.

In figs. 1, 2, 3, plate VI., are presented fair average drawings of the three forms in their normal condition, and in figs. 4, 5, 6, 7, and 8, 9, 10, 11, and 12, 13, 14, 15 are shown the successive states presented by average specimens, taken in the case of each monad during the fourth and fifth months after being static at 78° Fahr.

This vacuolation was not necessarily permanent. The vacuoles could often be seen to gradually get nearer to each other and unite into a larger one; and in the process of fission the vacuoles would often divide, and in some cases partly, or even wholly, disappear. But in a sexual fusion of two forms all this vacuolation disappeared, and the sac presented a perfectly normal condition.

After the fifth month I found, on careful trial, that I could without much discoverable inconvenience to the organisms raise the temperature a degree, and in the course of three months, by very delicate increments, I had reached 80°.

During this time the vacuolation, which was, as I have said, no proper feature of these forms as I knew them at normal temperatures, disappeared very gradually, and they were, in condition, form, and activity, much as they were at 60°.

The advance from this point had to be gradual; either too large an increment, or too short an interval of time, again wrought visible damage, and had to be at once corrected; but as the temperature advanced, there was no alteration anywhere perceptible in the sarcode of the organisms; nor did they alter in the least as to the details of fission or sexual fusion. The time occupied and the manner were as described for ordinary temperatures.

By very slow elevation of temperature, extending over nearly nine months, I reached 93°, and during all this time I could detect no divergence from the same organisms when seen at 60° Fahr. They resented a too rapid elevation of temperature, and I had constantly to return to the last static point for longer or shorter periods before a sure advance was made. It was evident that a physiological adjustment had to be brought about, adapting the organisms to each fresh elevation of the thermostat, before any successful progression could be made.

But beyond the point of 93° I could not go without causing all three of the monads to surrender to torpor and death, until I had submitted to what proved to be a prolonged continuance of the static 93°.

I tried to elevate the heat by most delicate advances, the smallest fraction of a degree of which the apparatus was susceptible, at intervals of one month for three months successively, but with such adverse results, visible in a couple of hours, as made it necessary to go back to a lower point than 93° in order to restore complete vigour.

But during this time I began to discover a renewed tendency to vacuolation. In this instance it commenced in very minute vacuoles, and they were sparsely distributed, but in each of the three monads steadily increased in number, but did not, as in the former instance, fuse into larger vacuoles, but only increased in number. In figs. 16, 18, 20, are drawings of *M. Dallingeri*, *D. Drysdali*, and *T. rostratus*, as they were in the fourth month with a static temperature of 93°, while figs. 17, 19, 21, show corresponding organisms at the end of the fifth month, under the same circumstances. This represents the extreme state of vacuolation attained, and at the end of the ninth month, and not until then, was I able to elevate the temperature of the fluid a degree. But in the course of three weeks at 94° they became perfectly normal, lost all trace of vacuolation, and were most active and prolific, and submitted without great inconvenience to an elevation of temperature up to 102° in fourteen weeks.

After this there was a slightly increasing difficulty until I reached 107° which took two months, and there another pause ensued. During the next three months a relatively slight vacuolation took place, and permitted a further addition to the temperature until after seven months more, with smooth careful progress I reached 137°.

This appeared to be a very critical point, for directly the 136th degree had been passed there were symptoms of oppression and distress, and on touching 137° this was very manifest.

I was compelled to play the thermal point back and forward for three weeks before there was an approach to normal activity and fecundity, but beyond this point I dared not advance.

In putting a drop, for example, upon a thermal stage, at the point 136°, and then elevating it slowly through 137° to 138°, torpor became universal in all the three organisms in the field.

My only hope of further advance was in patience.

After six months of constant and careful endeavour, not the slightest advance appeared to be made. There was no greater readiness than before, and I began to despair of further success, no vacuolation or any other feature that could be noted was discoverable. In this way I continued the observations, with constant test experiments for twelve months, and with no apparent advance.

But at the end of this time I saw that a slight tendency to endurance of a minute elevation towards 138° was visible, and with it a rapidly increasing growth of vacuoles, which spread as before through the sarcode of each of the three forms, but the tendency was for these to pass from small into large vacuolations. In a month these were universal, and in figs. 22, 23, 24, 25, I have drawn successive stages of this condition, as they appeared in one month from the beginning of the process.

During this time I had been able to raise the temperature 4°, and the vacuolation disappeared rapidly. The progress was now as rapid as it had been slow previously, and admitted of as much as 2° elevation at a time, and without further difficulty I slowly progressed to 150°, more slowly to 155°, and was again brought to a dead standstill at 158°.

Here, with such pain as I presume is natural, I have to close the

story. The accident happened, destroying the use of the instrument, and causing the whole to collapse.

I preserved the sediment of my vessels, and have, as I have said, begun the work again, and with precautions and suggestions begotten of experience, that I can only hope may not make that experience after all dearly bought.

But it is a matter of interest to know, that although I did not succeed in raising the temperature in these forms to anything like the elevations that the algæ and other low forms have been found in nature to flourish in, yet there seems to be indicated in these observations, imperfect as they are, that there is at certain points in the endurance of cumulative thermal elevations, a distinct physiological change brought about with greater or less difficulty, which seems to be directly correlated to the power of adaptation to a given measure of heat increment. It is not a quiet rhythmic progression. There are points of greater and of less difficulty.

How far these may be capable of association with certain chemical and physical, or even physiological conditions I do not pretend to say, nor do I wish to draw any general inference as to even this *group* of organisms. My observations were only on these three special forms. But the fact is suggestive, and it is the more so when taken in relation with an additional fact.

These organisms and their congeners generally, of the septic group, flourish at 65°, and are killed at 140° Fahr.

But if the adapted organisms at 158° F. were taken from that temperature and placed in an eminently nutritious and suitable nutritive fluid at 60° they died. While, of course, if forms of the same kind exactly, living and flourishing at 60°, were placed in a nutritive sterilized fluid at even 150° they were finally destroyed.

I can only claim for this fragment its suggestiveness, and its possible value as an incentive to others to treat the lower and minuter forms of life in corresponding manners, and as showing that such work cannot be without value.

VI.—*On Cutting Sections of Sponges and other similar structures with soft and hard tissues.*

By Dr. H. J. Johnston-Lavis, F.G.S., and Dr. G. C. J. Vosmaer.

(*Read 9th March*, 1887.)

The difficulties that are involved in the study of structures where the component tissues have different physical or chemical properties, are such that in some cases the histological or anatomical arrangement has never been thoroughly understood. Perhaps there is no better example of the above difficulties to be found than the Porifera, in which the biologist has to contend with a very complex intermingling of hard and soft substances of entirely different chemical as well as physical properties. We have, in fact, a remarkably delicate protoplasm enwrapping various complicate spicules and granules of siliceous nature. Although many sponges only possess a few spicules, there are others the skeleton of which is so extremely hard that it is utterly impossible to cut through them with the ordinary cutting instruments. It is true sections have been made, even of very hard sponges, but then only relatively small ones can be obtained; it is, however, an obvious advantage to be able to cut large sections, in order to be better able to study the relation between the canal system and the skeleton.

Thinking over the mechanical difficulties that thus hinder success, the true solution of the problem is obviously based on a suitable method of equalizing the hardness of the two substances composing a sponge, and which practically consists in rendering the sarcode sufficiently hard and cohesive to withstand the mechanical treatment necessary in cutting the hard siliceous spicules, of retaining all their structure in their relative position, and at the same time not to destroy or even change the histological characters of the most delicate tissue.

With this object Prof. Sollas has succeeded in making sections through hard siliceous sponges by means of the freezing microtome. The objections to the method are manifold—the difficulty of keeping the temperature low, and manipulating under such conditions—the comparatively small increase in the cohesion of the sarcode.

The method employed by Prof. Von Koch for corals has the great disadvantage of taking too much time if one wishes to make rather large sections; besides, copal is a substance of which it is difficult to make clear solutions of different strengths.

Marshall's note about plunging the sponge into boiling Canada balsam shows much of the skeleton and some parts of the canal system, even now and then something of the tissues, but the method is too rough.

The method we now describe fulfils all the necessary conditions, and is capable of being used with the most delicate stains and of affording complete and entire sections of unlimited size, results almost impossible with soft though tenacious tissues. The only objection that can be urged against our method is that it is somewhat tedious, but in this it has great

advantages over Koch's method, and is not much longer than the sectionizing of pumice-stone devised by the first-named of the authors of this paper.* In fact this process was suggested to us by this latter method combined with that of Prof. O. Sankey, which most beautifully demonstrates how even a tissue like the brain, with its delicate cells and nerve-filaments, can withstand drying.

The method we now describe has the following points in its favour:—it renders the protoplasm sufficiently hard to be treated as fossil sponges; it does not destroy histological details more than a paraffin imbedding; it permits the making of sections of unlimited size; every spicule or other unfixed object remains in its place. The objections to it are its somewhat tedious character, requiring patience and a certain amount of skill and ingenuity in carrying out the various operations; but after all, this equally applies to all methods.

The materials required are, besides the specimens and staining materials, Canada balsam dissolved in benzole, a thick and a very thin solution, hard balsam such as is used in cutting rock sections, a grindstone with a flat side,† and a good-sized hone, say $2\frac{1}{2} \times 1\frac{1}{2} \times 8$ in., a solution of soap in equal parts of alcohol and water, and a small stream of clean water.

A thin slice is cut with a very sharp thin knife from the whole or part of a sponge hardened in absolute alcohol of a thickness of from two to five lines, according to the size and structure of the specimen. This, after the usual staining process, is returned to absolute alcohol and a few drops of benzole are added; after an hour some more benzole, and so on. The next day the object may be placed in pure benzole. If one adds the benzole too quickly the object shrinks and is spoiled.

From the benzole it is transferred either into the benzole-balsam solution or lumps of balsam are added to the benzole bath in which it was. The quantity of the balsam is either increased by the use of a more concentrated solution or by adding more hard.

After the object is well penetrated it may be dried in the air for one day, after which it is transferred to a kind of hot-air bath, of which we give a sketch and description. Provided the tissues are thoroughly penetrated by the balsam, they can withstand complete drying up, and even in order to accelerate the process, they can be exposed to a temperature of 80° C. or more. Usually after some days, or in the case of large objects after some weeks, the section is hard enough for grinding. In order to be successful it is necessary to see that balsam fills every hole, and if such is not the case, to apply some thick solution which may be used warmed. If, on commencing to grind, as it will sometimes occur, that the balsam is not hard everywhere, or even if one can make an impression with the nail, it must be returned to the oven. To prevent fracturing in consequence of the balsam being unannealed, it is advisable to gradually lower the temperature toward the end of drying. In cases of very large slices it is convenient to bring them in complete contact with the surface of the glass slips upon which the specimens are

* See this Journal, 1886, p. 22.

† An ordinary grindstone trimmed with an old file, or a piece of flat sandstone answers very well.

drying, so that this may act as a support whilst one side is being ground down. Short corks may be attached by means of marine glue to each end of the slide, so as to afford a firm hold.

We are now in possession of a hard mass, the future treatment of which resembles that by which a piece of pumice is sectionized by the first author's method. The fragment if large must, as already has been mentioned, be attached during drying to a piece of glass, but if of fair thickness a section two centimetres or three-quarters of an inch may be held in the fingers. The flatter or more complete side is held against the side of a grindstone, or rubbed in a circular manner on a flat slab of the same material until a fairly level surface has been obtained. A small quantity of carbonate of soda or, better, soap solution may be added to the water, to prevent the stone clogging with the balsam and tissue ground off. The quantity requires careful watching to prevent dissolving more balsam than is ground off, in which case the section will appear cloudy when finished.

After washing, the ground face is now applied to the hone and a drop of the solution of soap in alcohol and water is to be put upon the nearly level surface of the stone upon which water is slowly dropping. The grinding is now continued until a fine level surface has been obtained. From time to time the object will begin to catch on the stone and little rolls of balsam form, which is an indication for more soap solution. When a perfectly level smooth surface has been obtained, the object is washed in clean water with a soft tooth-brush or a camel's hair pencil, dried and warmed just sufficiently to drive out any moisture in cracks or cavities, *but not to soften the balsam.*

The permanent glass slip is now cleaned with alcohol and varnished with oil of cloves (slightly grinding the surface is sometimes useful in order to make the object stick to the glass), then heated and rubbed with perfectly hard balsam, so as to leave a thin layer of this substance covering the slip. The ground face of the specimen is also very thinly varnished with oil of cloves, and pressed into the warm balsam so as to come in complete contact with the glass, avoiding air-bubbles, &c. Large sections can rarely be fixed at once in this way, therefore they are put on a piece of paper which lies on an elastic mass, such as some sheets of paper, a piece of indiarubber, &c., and the glass touched by the flame opposite points where the object is not yet fixed, pressing it into contact at every point. The preparation is now allowed to *cool very gradually* to anneal the balsam.

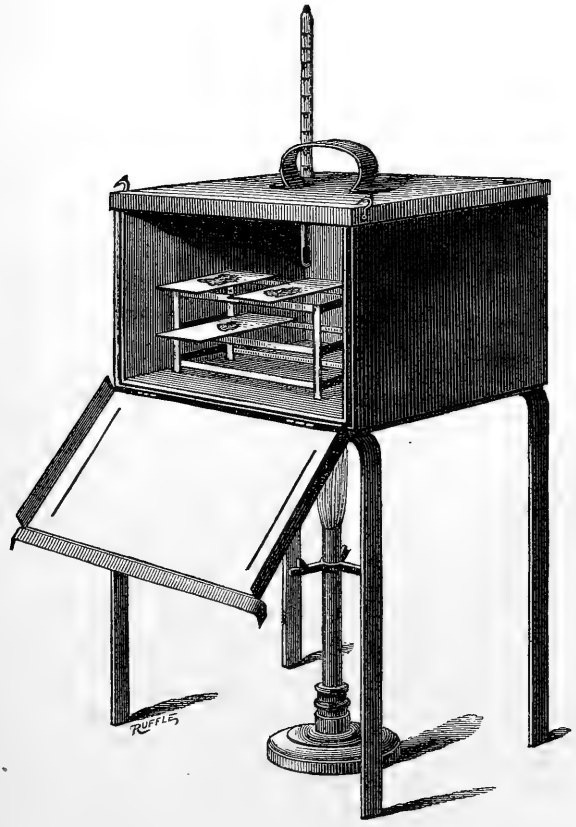
The object is now brought against the circumference of the grindstone, and the thickness reduced all over. When we have removed as much as convenient, the flat side of the stone may be used and the preparation levelled down to almost the requisite thinness for microscopical examination. It is now transferred, after washing, to the hone for the final grinding, which requires great care and gentleness to prevent the edges of the section cracking away. If such is persistently the case in some examples the mass may after the stoving be enveloped in plaster strengthened by threads, a method suggested by Prof. Von Koch. When the desired thinnesss is acquired the section is again thoroughly washed in water with the aid of a brush, and spontaneously dried. When

dry it is washed with chloroform, benzole, or turpentine and finally mounted in balsam as an ordinary section.

The method will strike the reader as a long one, tedious, and open to failure in consequence of the number of different processes involved; but by preparing a number at once much time is saved, and one failure prevents our exposing ourselves to a repetition by teaching us in what way we have erred. At any rate the whole goes quicker than Von Koch's method and does not injure the object as in the too rapid method of putting the object into boiling balsam. We have succeeded in making large sections of the very hardest sponges, showing most of the cells as little altered as in paraffin-prepared objects, and in one case the preparation includes a section through a gasteropod shell. It is possible to make sections of an unlimited size, a great advantage for studying the relationship between the canal-system and the skeleton.

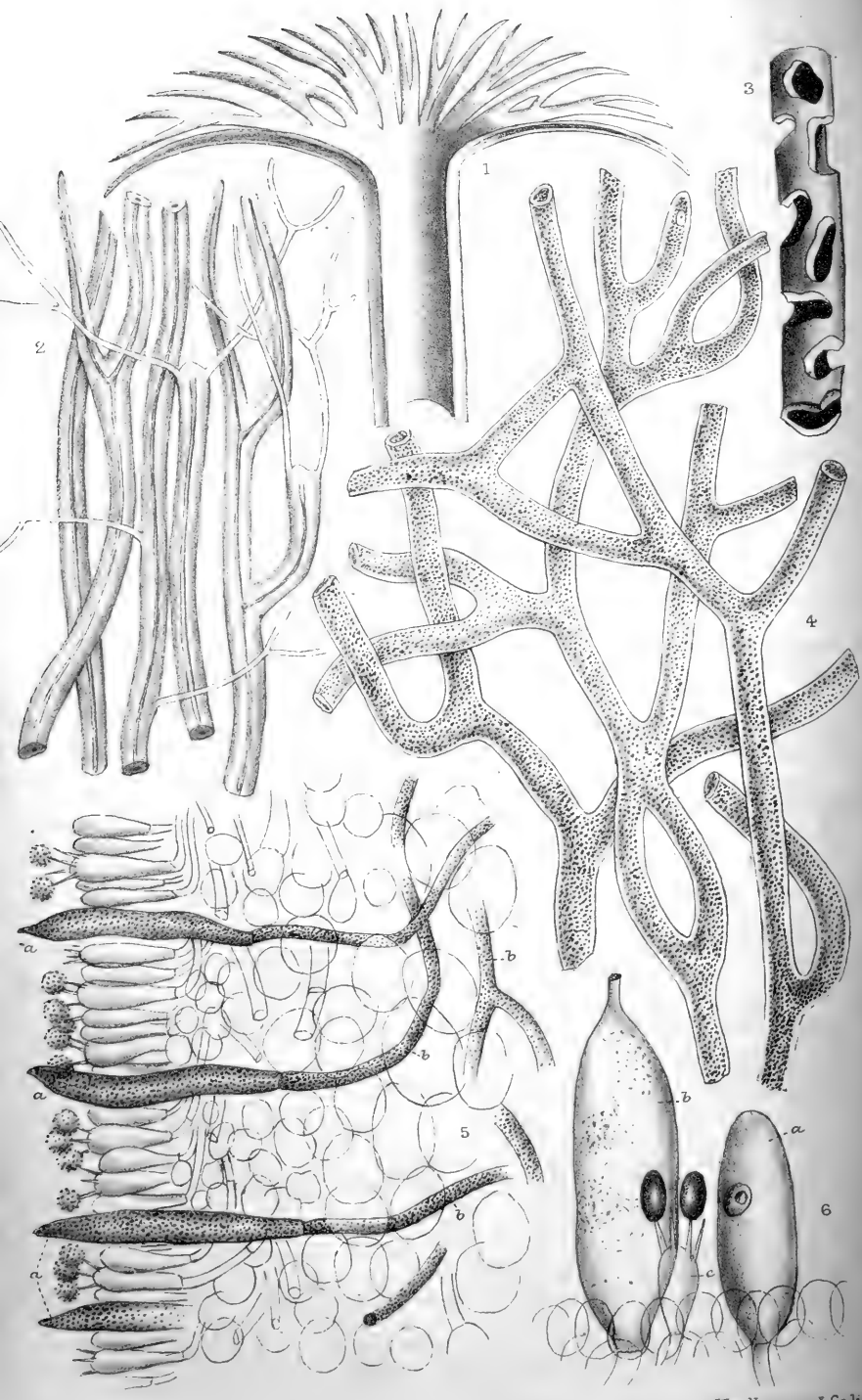
We have still to describe the little oven constructed by the second-

Fig. 34.



named author. This oven (fig. 34) consists of a brass box the inner walls of which are lined by asbestos cardboard, whilst the bottom is

alone of this latter material, so that we may produce a very equal heating from all sides of the sponge preparations. On one side of the oven is a door which flaps downwards, whilst the cover also is made to flap backwards. Through the latter a thermometer and if desired a regulator may be put as in an ordinary chemical hot oven. The whole is supported on metal legs of a convenient height. Within is a metal rack with shelves at different heights; the slides or preparations are placed for the first few days on the top shelf and are afterwards gradually lowered.



West, Newman & Co lith.

G.M. del ad nat.

Illustrating Mr Massee's paper on Tissues in Fungi.

VII.—*On the Differentiation of Tissues in Fungi.*

By George Massee, F.R.M.S.

(*Read 9th March*, 1887.)

Plate VII.

In the Rev. M. J. Berkeley's collection of fungi, now in the Kew Herbarium, is a specimen marked "*Polyporus pisochapani* Nees." The plant is old and brittle, part of its substance having been reduced to powder by minute fungus-eating beetles; nevertheless, the fact of its being in this condition constitutes its special value in connection with the present subject, that of illustrating in a marked manner the sharp differentiation of its component hyphæ into two distinct systems, mechanical and reproductive. The first, being most durable, is almost intact; the latter much decayed, yet sufficient remaining to show clearly its original arrangement. The mechanical component forms an unbroken hollow cylinder in the stem near to its periphery; its substance is about half a line thick, and is surrounded at some little distance by the indurated cuticle. At the apex of the stem this tube widens out into a funnel-shaped body, which becomes broken up into a number of ribs, radiating from the central portion to the margin of the pileus. The substance of the stem portion of this mechanical sheath is solid, and in the dry state as hard as cocoa-nut shell, but the ribs or radiating portions of the pileus are hollow, taper to a fine point, and are sometimes connected by transverse bars. The pileus, like the stem, is covered with a cuticle.

Examined microscopically, the mechanical ring is seen to be composed of eseptate hyphæ of a rich brown colour, and with very thick walls; in fact the cavity is in most cases obsolete. In the centre of the ring the hyphæ are rarely branched, closely compacted, and often more or less polygonal in section from mutual pressure. Towards the outside the hyphæ are frequently branched, the larger branches being mostly vertical and terminating abruptly in from two to several slender filaments spreading in a flabellate manner. Numerous small branches also originate from various points throughout the length of the large hyphæ, more especially those situated on the peripheral side of the strengthening ring; these small hyphæ, by repeated branching, form a plexus which becomes very intricate and densely compacted on the

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EXPLANATION OF PLATE VII.

Fig. 1.—Portion of mechanical sheath of stem and pileus in *Polyporus pisochapani*; natural size.

Fig. 2.—Hyphæ from peripheral part of mechanical sheath of stem of *P. pisochapani*; × 400 diam.

Fig. 3.—Portion of mechanical sheath from stem of *P. rugosus*; natural size.

Fig. 4.—Laticiferous vessels from stem of *Lactarius torminosus*; × 500 diam.

Fig. 5.—Portion of transverse section through gill of *Russula fœtens*; *a a*, cystidia continuous with *b b*, laticiferous vessels; × 500 diam.

Fig. 6.—Portion of margin of gill of *Coprinus atramentarius*, showing a young cystidium with hyaline protoplasm and a nucleus at *a*; *b*. an old cystidium; *c*, a basidium with four spicules or spore-bearers: only two of the spores are shown.

outside forming the cuticle, where, owing to the diffluent walls, the threads are agglutinated together, and form a hard brittle crust when dry. The thick hyphæ forming the framework of the pileus also give origin to fine lateral branches, which are at first but little compacted, but eventually become densely felted, and form the cuticle of the pileus. A few small branches, springing from the hyphæ situated on the inside of the thickening ring, form a loose framework in the hollow of the stem; a similar framework originates from the under side of the strengthening rays of the pileus. The structures already described are purely mechanical or protective in function, and consist entirely of very thick-walled, eseptate hyphæ. The second or reproductive portion, on the contrary, is composed of very thin-walled septate threads, generally copiously branched, forming compact but not hardened masses, except in the hymenium or spore-bearing portion. This latter system occupies the central cavity of the stem within the mechanical ring, from which it extends through the framework between the ribs and the cuticle of the pileus, forming the so-called flesh, then passes down between the ribs and gives origin to the porous hymenium.

There is no evidence of any organic connection between the hyphæ of the two systems, in either stem or pileus; and in all probability, differentiation takes place before the plant emerges from its vegetative mycelium.

Polyporus pisochapani * has a pileus about three inches across, a central stem about four inches long and more than half an inch thick. Other species of *Polyporus* in the same collection, in a more or less decayed condition, show a similar differentiation of tissues. *P. rugosus* Nees has the mechanical sheath of the stem irregularly perforated, while in *P. lepideus* Fr. and *P. floccopus* Rostk., the corresponding portion of the pileus consists of a perforated plate, which sometimes shows a tendency to become broken up into ribs, as in *P. pisochapani.*

No member of the Agaricini, so far as I have been able to ascertain, shows such a marked division of labour amongst its component hyphæ for purposes of support; nevertheless, in most species, there is a well marked cuticle to the pileus composed of slender felted hyphæ, and the stem generally becomes hollow with age, a firmer peripheral portion remaining, which probably corresponds to the more highly developed mechanical sheath in the stem of *Polyporus.* If however, the supporting hyphæ differ but little from those concerned with reproduction in the gill-bearing agarics, we find in some genera, as *Lactarius* and *Russula*, a highly specialized laticiferous tissue, which is distinct from the earlier stage of development. The vessels of this system generally form bundles in the peripheral portion of the stem, from whence they pass into the pileus and gills. In *Lactarius* two types of structure occur; the vessels are the result of cell-fusion, only few of the transverse septa remaining, as in *L. deliciosus;* † or they consist from the first of eseptate hyphæ, much branched and frequently

* *P. pisochapani* Nees = *P. amboinensis* Fr. 'Grevillea,' xv. (1886) p. 58.

† For detailed description of the laticiferous system in this fungus, see Prof. A. Weiss, SB. K. Akad. Wiss. Wien, xci. (1885) pp. 166–202 (4 pls.).

anastomosing, as in *L. torminosus;* the last type is most general. The latex consists of exceedingly minute granules floating in liquid, and is always colourless (white) when in the tissues, but on escaping into the air frequently changes colour, becoming red in *L. deliciosus,* lilac in *L. uvidus,* and golden yellow in *L. chrysorrheus.* The colour is due to some change taking place in the granular portion, the liquid remaining colourless.

The walls of the vessels are exceedingly thin in the species of *Lactarius,* and liberate the latex or "milk" on the slightest touch.

This tissue is undoubtedly connected with nutrition, or the transportation of food-material, in the form of *glycogen,* which is considered by Errera * to be of the same value in the nutrition of fungi as starch is in chlorophyllose plants, and the reagents enumerated by this author show that glycogen abounds in laticiferous vessels. In studying this system, or testing for glycogen in species of *Lactarius,* it is advisable to allow the plants to remain for a few days in a dry place, during which time the more liquid portion of the latex evaporates, and sections can then be cut without further loss of this substance, which in fresh plants flows from the vessels at once, when injured; neither is the reaction so evident in fresh as in dried specimens. If sections from plants prepared as above are slightly warmed in a solution of iodide (water, 45 grm.; potassic iodide, 0·3 grm.; iodine, 0·1 grm.) those parts containing glycogen assume a dark orange or reddish-brown colour, depending on the quantity present; the colour becomes paler when heated to between 50°–60° C., and returns on cooling. In such preparations the laticiferous vessels stand out as dark-brown lines. In the genus *Russula* the liquid portion of the latex is scanty, so that it does not flow from the vessels when cut; nevertheless the contents assume a dark reddish-brown colour when treated with iodine as above, and in *R. fœtens* Fr., by means of this method of staining, I have satisfied myself by repeated observations that the cystidia met with in the hymenium of most, if not all, gill-bearing fungi are simply the terminal cells of laticiferous vessels. These bodies, on account of their large size and peculiar properties, have been the subject of much controversy and speculation: † by de Seynes ‡ considered as aborted basidia; by others, as Corda, Hoffmann,§ and more recently by Worthington G. Smith,‖ as male reproductive organs; hence the names *pollinaria* and *spermatia* applied to them. Cystidia are very numerous in the hymenium of some species of fungi, rare in others, and in some perhaps altogether absent; but in connection with this question I cannot do better than give an extract from the article by W. G. Smith already quoted:—"The receipt of the magnificent specimens of *Agaricus bombycinus* from your correspondent the Rev. J. M. Du Port, has again directed my attention to the subject of cystidia in agarics. Knowing by experience how fine the cystidia are in some near allies of

* Mem. Acad. R. Sci. Belg., xxxvii. (1885) and Bot. Zeit., xliv. (1886).

† A. De Bary, "Morphologie und Physiologie der Pilze" in 'Hofmeister's Handbuch,' ii. (1886) cap. v. Translated in 'Grevillea,' i. (1873), p. 181.

‡ 'Essai d'une Flore mycologique de la région de Montpellier,' Paris, 1883.

§ "Die Pollinarien und Spermatien von *Agaricus*," Bot. Ztg., xiv. (1856) pp. 137-48, 153-63.

‖ 'Grevillea,' x. (1881), p. 77, and 'Gardeners' Chronicle,' Sept. 17, 1881, p. 369.

A. bombycinus, the first thing I did on receipt of the specimens was to look for the cystidia. For several hours of the night my efforts to find anything were unavailing; at last I saw one, soon afterwards two others (in the hymenium), at length two more; they all agreed exactly in their great size (longer than any here illustrated), in their spindle shape, and in being without spicules at the summit. The cystidia must be extremely rare in *A. bombycinus*, and this fact will give some one a good opportunity for saying he cannot see them, or for some rash person to deny their existence altogether." In a section of the hymenium these bodies, when present, are easily known by their large size, usually projecting much beyond the basidia with their spicules and spores. When young the cystidia, which may be considered as the growing points of latex vessels or hyphæ, contain hyaline protoplasm and a large nucleus with a nucleolus—corresponding to the nuclei present in other parts of the laticiferous system—but when they have attained their full size the protoplasm is replaced by a finely granular substance containing glycogen, which eventually escapes through a nipple-like or filiform attenuation at the apex of the cystidium. In some species four or more of these attenuations are present, and arranged in a similar manner to the spicules surmounting a basidium, which has led to the idea on the part of some that cystidia may be abortive basidia. In the young hymenium cystidia may be met with in all stages of development, and are always cut off by a septum from the vessels they terminate, at which point they break away and drop off after the escape of their contents. As to their function, nothing definite can be stated, but I am inclined to believe that their contents are poured out for the purpose of supplying a certain amount of food to the developing spores, which in many species are bathed with it during growth.

Laticiferous vessels are by no means confined to the above-named genera, but are widely distributed throughout the order, being especially well developed, and containing abundance of latex, in *Peziza saniosa* Fr. Neither do I consider the whole of the latex as consisting of glycogen, but that it is present in the laticiferous vessels along with other substances, being especially abundant during the early stages of the plant's development, and replaced later on by a substance assuming a blackish-brown colour with iodine or dilute sulphuric acid, which does not change when heated.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Germinal Layers.‡—Dr. W. Wolff communicates a critical historical review of the progress of knowledge from Pander onwards in regard to the history of the germinal layers. He travels over somewhat familiar ground in his account of gastrulation and the like, and gives expression to several opinions which hardly seem to have been sufficiently focused. The principal point in his article is his insistance that the mesoderm, or Mittelkeim as he prefers to call it, cannot be said to arise from the endoderm. The constituent cells have an independent pre-endodermic origin, and represent the surplus of segmentation cells not used in forming the gastrula. It might be argued that whatever be the sphere of *à priori* speculation, embryological generalizations should be kept in as close touch as possible with known facts.

Karyoplasm and Inheritance.§—Prof. A. Kölliker has some remarks on the theory of Prof. Weismann with regard to the continuity of germplasma. He urges that the idioplasm found in the nucleus of the fertilized egg-cell increases in size during the course of development, but passes with its internal structure unaltered into the nuclei of all the cells which take part in the formation of the embryo; and he denies, consequently, the fundamental difference which is asserted to exist between somatic cells and those of the tissues on the one hand, and the ovarian and seminal cells on the other. He asserts that in the metamorphoses of the embryonic cells into the specific elements of the tissues the primitive nuclear idioplasm often completely retains its typical peculiarities, but in other cases retrogression takes place and this idioplasm disappears.

Prof. Kölliker's idea about the structure of idioplasm is this: we cannot doubt that the basis for the whole organization of the future

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

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

‡ Arch. f. Mikr. Anat., xxviii. (1886) pp. 425–48 (1 pl.).

§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 228–38.

creature is contained in the idioplasm of the fertilized egg-cell; by the activity of the nuclei simpler organs, such as the germinal layers, first appear; then come more developed structures, such as the enteric, nervous, and osseous systems; all these developments have one and the same molecular structure of the nuclei, modified in various types, and slightly variable in the individuals of a given type; but this is of such a kind that the idioplasm has essentially the same structure in every stage of development. But it is not to be supposed that the later organization is to be found in rudiment in the idioplasm of the fertilized egg-nucleus. All that is necessary to suppose is that typical regular movements take place in the nuclei, and that these are dependent on the structure of their idioplasm.

Let us suppose that in one case a fertilized egg-cell divides into quite equal parts n times, and in other $n + x$ times, we shall have two aggregates of cleavage-spheres varying in size. If, then, there are more nuclear divisions in thickness and breadth in one organism than in the other, we shall have fresh differences; and thus in every rudimentary organ a new type may arise by a special multiplication of nuclei in kind and number. Finally, we have histogenesis which is again referable to nuclei, where the idioplasm is for a long time the same in all the nuclei, but at last becomes quite lost in certain elements (blood-cells of mammals, integumentary scales, &c.).

Development and Significance of the Germinal Epithelium in the Testicle of the Chick.*—Prof. F. Laulanié comes to the conclusion that the elements of the testicle of the chick have no genetic relation to the germinal epithelium or to the Wolffian body; these elements arise in the stroma of the genital epithelium by a simultaneous differentiation; the germinal epithelium becomes the seat of an active proliferation, which has not hitherto been perceived; the nucleus of the cylindrical cells undergoes segmentation, the ovules divide, and at certain points penetrate into the sub-epithelial connective zone. These facts prove the tendency of the germinal epithelium to develope cortical ovules at the periphery of the testicle, while the seminiferous tubes are formed in its interior. Prof. Laulanié thinks that, the male elements having no common origin with the female elements, the double effort points to a morphological duality. This idea of the hermaphroditism of the testicle is supported by the fact that the evolution of the germinal epithelium is seen only in the left testicle; one law, therefore, regulates the development of this epithelium in the two sexes, and affords another argument in favour of an organic and primitive hermaphroditism.

Conditions of Tadpole Metamorphosis.†— Dr. D. Barfurth gives a detailed account of the series of experiments on tadpole development, as the result of which the following conclusions were established:—(1) low temperature retards metamorphosis, (2) quiet curtails it, (3) fasting also shortens it, (4) cutting off the tail is either without influence on the metamorphosis or retards it, (5) in the majority of cases *one* of the anterior extremities, usually the *right*, has the start of the other. In an appended paper he emphasizes the influence of hunger, or rather fasting, as a factor in development. In tadpole metamorphosis the extremities are completely developed some time before they are able to break through the covering skin. This liberation takes place as the skin becomes thinner and less firm. This is brought about by absorption of the elements of the cutis, which obviously takes place more rapidly in fasting animals, so that fasting

* Bull. Soc. Hist. Nat. Toulouse, xx. (1886) pp. 13–6.
† Arch. f. Mikr. Anat., xxix. (1887) pp. 1–34 (1 pl.).

is a factor influential in shortening the last stages of metamorphosis. With this other parallel phenomena are compared, and the author emphasizes the extent to which the economy of the organism is self-adjusting.

Absorption of the Tadpole's Tail.*—Dr. D. Barfurth has made a careful study of the exact manner in which the tadpole's tail gradually disappears. (1) The epidermis cells are simply atrophied, grow old, shrivel up, and die. (2) In the capillaries and smaller vessels the lumen disappears with disuse, and the elements on the walls fall off in small fragments to be eaten by leucocytes or dissolved. (3) The notochord and nerve-fibres seem to exhibit similar degeneration. The spinal cord cells become turbid and infiltrated with nuclear débris. (4) The muscle-fibres exhibit disruption into sarcolytes, fatty degeneration, and nuclear proliferation in the perimysium internum. (5) Leucocytes appear throughout devouring the débris, and carrying it to the lymph-vessels. (6) The material is used up for the development of more essential organs and tissues.

These degenerative processes begin only when the tissues are in process of death. The phagocytes appear, as Metschnikoff notes, when definite irritant elements or foreign bodies are present. The tissues begin to die in consequence of insufficient nutrition, and this in consequence of the cessation of trophic influence from the nervous system. The trophic influence ceases because the function of tail, after the appearance of the fore limbs, is superfluous. The weal of the entire organism finds expression through the central nervous system.

Intra-ovarian Egg in Osseous Fishes.†—Dr. R. Scharff has studied the intra-ovarian egg, chiefly in *Trigla gurnardus.*

In the youngest ova the nucleus occupies nearly the whole cell; the nucleoli being peripheral. Later, the surrounding protoplasm increased, and a darker internal portion can be distinguished, which arises from the nucleus. When the egg has almost reached its final size, the nucleus shrinks, and protuberances appear on all sides; these become constricted off and travel to the periphery of the egg. The author does not consider that the nucleus, although it degenerates, ever entirely disappears.

The most external membrane is the "zona radiata," within which a semi-fluid layer exists, which later disappears. A peculiar modification is noticed in the follicle cells of the egg of *Blennius photis.* As to the development of the ova, the author is inclined to think that only one cell is concerned. The egg-membranes do not appear till after the follicle.

Growth of Embryos of Osseous Fishes.‡—M. L. F. Henneguy finds that a series of longitudinal sections of the embryo of osseous fishes shows that, during the extension of the blastoderm on the vitellus, the embryo grows chiefly in the part comprised between Kupffer's vesicle and the protovertebræ; new somites are constantly formed in the anterior portion of this region. If this view be correct, it can hardly be brought into agreement with the theory of His, though it is compatible with the hypothesis of Kupffer and Oellacher. M. von Kowalewski, who has been studying recently the development of the ova of such Teleosteans as have ellipsoidal eggs, has been able to prove that, at the moment when the germinal layers are differentiated, the blastoderm grows along the whole of its periphery, but that the caudal extremity of the embryo remains fixed on a point of the vitellus. The author thinks it is very probable that the same is true of osseous fishes with spherical eggs.

* Arch. f. Mikr. Anat., xxix. (1887) pp. 35–60 (2 pls.).
† Proc. Roy. Soc., xli. (1886) pp. 447–9. ‡ Comptes Rendus, civ. (1886) pp. 85–7.

Development of Petromyzon fluviatilis.*—Mr. A. E. Shipley differs from Mr. Scott in his description of the formation of the mesoblast, for he finds that the ventral mesoblast is formed by the downgrowth of the mesoblastic plates, which ultimately meet and unite in the ventral middle line. Max Schultze was more correct than later observers in stating that the blastopore does not close up, but remains as the anus; there is no neurenteric canal. Anteriorly the hypoblast remains connected with the epiblast, and here the gill-clefts arise, the mesoblast growing down between them to form the gill-bars. The peculiarly constructed muscle-plates each arise from a single cell of the mesoblastic somites, the nucleus of which divides until each cell contains several nuclei; striated fibrils then appear to increase till the whole muscle-plate consists of little else; these "plates" arise from the segmental half of the mesoblast, while the muscles of the gills, lips, and probably of the eye, arise from the ventral unsegmented part and have a different structure. The blood-corpuscles arise from the ventral free edges of the mesoblast; the heart appears in the ventral mesentery, formed by the union of the lateral mesoblastic plates, and is at first continuous with a large sinus which lies just behind it. As this sinus acquires walls, it forms part of the subintestinal vein.

The ciliated funnels of the pronephros are left as apertures, owing to the closing up at intervals of the groove which forms the segmental duct. The canal of the central nervous system developes after the neural chord has separated off from the epidermis, and it does not appear to be lined by any invaginated epidermis. The first sign of cerebral differentiation is the formation on the sixteenth day of the optic vessels and pineal gland; the fore, mid, and hind brains appear a little later. The ganglia on the 5th, 7th, 9th, and 10th nerves are derived from epiblastic thickenings, and the ganglion of the fifth divides into two parts which have a common root. The origin of the ganglia on the cranial nerves has no relation to the sense-organs of the skin, which are not apparent in the oldest larvæ seen by the author.

The early development of the skeleton is described as far as the period at which began the researches of Prof. Parker.

Some Darwinistic Heresies.†—Prof. C. Vogt, while accepting all the fundamental points on which Darwinism is based, combats certain views which he regards as exaggerated or ill-founded. The idea with which we start, consciously or unconsciously, that nature sets before herself a purpose just as we do, is not just; he urges, for example, that, similar as all Equidæ are, they have a diphyletic origin. To deny this is to deny the facts of geological geography, and any phylogenetic tree which does not take it into account is by that fact alone erroneous or null. We must, then, conclude that there is a divergence of characters, and this is true of free-living as well as of parasitic organisms. Metamorphoses take place: (i.) By the reduction and final loss of primordial characters. (ii.) By the excessive and unilateral development of other characters which often originally existed only roughly sketched out. (iii.) By changes of function which imply the separation of parts originally united, and the fusion of other parts originally separated. If these statements are true there cannot be harmonious development in any organism, but only relative harmony, one or several organs being preponderant in development. Man himself, where everything is subordinated to the development of the brain, is a proof of this.

* Quart. Journ. Micr. Sci., xxvii. (1887) pp. 325–70 (4 pls.).

† Arch. Sci. Phys. et Nat., xvi. (1886) pp. 330–8; translated in Ann. and Mag. Nat. Hist., xix. (1886) pp. 57–61.

Further, the "fundamental biogenetic law" that the development of the individual is a compressed epitome of the history of the race, cannot be true; the contradictions which all embryologists recognize have been attempted to be explained as cenogenetic, or the results of falsified embryogeny. "Poor logic, how it is tortured! Nature falsifying herself!"

Phylogenetic speculations must, M. Vogt thinks, be completely reversed, and we must recognize that the less complicated animals owe their existence to a more or less complete retrogression, and that they must constitute the final terms and not the foundations of phylogenetic series. It is thought that such palæontological facts as the presence of Cephalopods and Dipnoids in the most ancient formations squares with the reformed hypothesis here enunciated.

β. Histology.*

Goblet-cells in Amphibian Bladder.†—Dr. J. H. List continuing his researches on goblet-cells, reports their presence in the epithelium of the bladder of Amphibia. The histology of the different layers is minutely described, and the form, size, and structure of the unicellular glands specially discussed. They arise in the deeper layers, undergo the usual modifications, and finally disappear after distinct secretion of their modified mucous contents. The details are corroboratory of List's previous researches.

Nerves of Electric Fishes.‡—Herr Fritsch is of opinion that the fibres of the axis-cylinder in the elements of the central nervous system of electric fishes arise from the fusion of protoplasmic processes. The axis-cylinder begins as a conical protrusion formed from the fusion of broad processes, and penetrated by vessels (*Gymnotus*, *Lophius piscatorius*, *Malopterurus electricus*. In the ganglion-cells (spinal ganglia) of *Lophius*, besides the axis-cylinder, fine processes pass through the wall and fuse outside. He thinks it not unjustifiable to conclude that fine processes of the nerve-cells may fuse to form the axis-cylinder, even when their fineness makes demonstration impossible.

γ. General. §

Marshall and Hurst's Practical Zoology.‖—Prof. A. Milnes Marshall and Mr. C. H. Hurst have published a 'Junior Course of Practical Zoology,' which ought to be very useful to all those who go beyond the work laid down in Huxley and Martin's well-known handbook. The forms dealt with are *Amœba*, *Paramecium aurelia*, *Vorticella*, *Hydra*, *Fasciola hepatica*, *Hirudo medicinalis*, *Lumbricus terrestris*, *Anodonta cygnea*, *Helix pomatia*, *Astacus fluviatilis*, *Periplaneta americana*, *Amphioxus lanceolatus*, *Scyllium canicula*, *Lepus cuniculus*, *Gallus bankiva*, and *Columba livia*. This list will show how widely the authors have thrown their net. Valuable explanations will be found here and there among the directions for dissection; there are forty-eight woodcuts, most of which are original and are among the best and most suggestive that a student, young or old, could have put before him. In an appendix a list of reagents is given, with their mode of preparation and the use to which they are to be put.

* This section is limited to papers relating to Cells and Fibres.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 147–56 (1 pl.).

‡ Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) pp. 735–6.

§ This section is limited to papers which, while relating to Vertebrata, have a direct or indirect bearing on Invertebrata also.

‖ A. Milnes Marshall and C. H. Hurst, 'A Junior Course of Practical Zoology,' 8vo, London, 1887, 440 pp. (48 figs.).

B. INVERTEBRATA.

Dotted Substance of Leydig.*—Dr. B. Haller has a note on the so-called Leydig's dotted substance in the central nervous system; the simplest condition of the central network of higher invertebrates is certainly to be found in some of the lower cephalophorous molluscs, such as the *Chitons;* in them the connective-tissue takes no part in the formation of the central plexus, which is exclusively formed of processes of ganglion-cells.

In the annelids *Lepidanthenia elegans* and *Nereis costæ*, the central non-ganglionated portion of the cerebrum consists of a nervous and connective plexus, which is traversed by commissural fibres and larger nerve-fibres; the inner fibres of the optic nerves arise from the central nervous plexus, while their outer fibres take their origin directly from the overlying larger ganglionic cells. The study of other groups leads the author to conclude that the central plexus is partly nervous and is partly formed by the processes of the ganglionic cells, and that this double mode of origin of the nerves is to be always found; as to the origin of this central nervous system it may be explained as being derived from that primitive system which covered the whole surface of the body.

Enterochlorophyll and Allied Pigments.†—Dr. C. A. MacMunn brings forward evidence decisive of the animal origin of enterochlorophyll, and of the presence of a true animal chlorophyll in *Spongilla;* in *Anthea cereus*, on the other hand, the chlorophyll is due to symbiotic algæ. The memoir contains also the author's observations on the saponifying of vegetable chlorophyll.

Myohæmatin and the Histohæmatins.‡—Dr. C. A. MacMunn adduces evidence in favour of the respiratory functions of these pigments, the discovery of which tends to confirm the theory that the formation of carbonic acid and the absorption of oxygen takes place in the tissues and not in the blood. Hæmatoporphyrin is identical with polyperythrin and is closely related to actinohæmatin.

Micro-organisms in Thermal Water.§—MM. A. Certes and Garrigou have been investigating the question whether there normally exist in thermal waters living organisms, and what part they play in the formation of that "glairine" and "barégine" which is found in sulphuretted waters. They conclude that in water taken at Luchon at a temperature of 64° C. there are rare very transparent mobile small rods, and more rarely immobile filaments, longer than the rods; in neither of these organisms were any granulations of reduced sulphur to be detected; no algæ, diatoms, or infusoria were to be seen, but the débris of vegetable or animal matter show that the waters are fertilized by atmospheric germs, and lead us to think they may be regarded as more or less successful culture fluids for such germs as can accommodate themselves to darkness, high temperature, and special chemical composition. When the water is not higher than 50° the masses of barégine appear; these are nothing more then zoogloœæ of rods mixed with grains of reduced sulphur. Further experiments are necessary to determine the chemical and biological action of the rods, and this knowledge will throw a light on the therapeutics of mineral waters.

* Morphol. Jahrbuch, xii. (1886) pp. 325–32.
† Phil. Trans., clxxvii. (1886) pp. 235–66 (3 charts and 1 pl.).
‡ Op. cit., pp. 267–96 (1 chart and 1 pl.).
§ Comptes Rendus, ciii. (1886) pp. 703–6.

Fossil Calcareous Elements of Alcyonaria and Holothurioida.*—Herr P. Počta has found in the calcareous strata of Bohemia not only Foraminifera, Ostracoda, and calcareous spines and needles of unknown origin, but calcareous elements which appear to come from a new species of Alcyonarian which he calls *Nephthya cretacea*, and plates which closely resemble those of *Psolus phantapus*.

Mollusca.

Histology of the Mollusc Liver.†—In a long memoir Dr. J. Frenzel reports the result of his investigation of the histology of the mid-gut gland or liver of Mollusca. His researches include a considerable number of representative forms from all the sub-classes. After a full historical introduction the author passes to the discussion of,

1. *The histology of the glandular epithelium.* (*a*) *The granular cells.*—Granular cells, the liver-cells of Barfurth, occur in all molluscs except Cephalopods. They are most developed in the Opisthobranchiata. They contain, besides protoplasm and nucleus, a distinct spherical vesicular ball, inclosing more or less markedly pigmented granules, fat-globules of various size, and albumen-clumps in variable abundance. The pigmented granules are constant, the others may be absent especially in ripe cells. The fat varies with external conditions, and the same may be said of the occurrence of crystals. The size, shape, and contents of the cells are discussed in great detail, as also the results of various reagents. The presence of a hair-fringe is noted, which in Cephalopoda and some Lamellibranchs is long and in the latter occasionally mobile. From this the author maintains a ciliated fringe might be derived.

(*b*) *The club-shaped cells*, or ferment-cells of Barfurth, vary very greatly in form and contents. All the different forms are regarded by Frenzel as modifications. They seem to occur in all types of molluscs. As in the granular cells, they contain a secretion-ball, also with more or less pigmented contents, which are however fluid, or at most drop-like. Fat and albumen clumps, and in one case a crystal, are again present. The size, form, contents, changes, and reactions of the cells are noted at great length. The secretion occurs in fluid drop-like form, in clumps, or in firm spheres, The secretion of the granular cells withstands strong acids which dissolve that of the clubbed cells, but the difference is really only quantitative. Herr Frenzel comes to no definite conclusion as to the origin of the club-shaped cells.

(*c*) *The lime-cells.*—There is a frequent, but by no means general occurrence of cells with strongly refracting spheres of calcium phosphate. The following chapter of the memoir discusses the actual occurrence of these three elements in specific forms.

2. *The physiology of the liver.*—Dr. Frenzel regards it as demonstrated that the mid-gut gland of all molluscs has a digestive function, and that this function is discharged both by the granular and club-shaped cells, while the lime-cells are certainly not secretory. The pigmented contents form the principal portion of the digestive ferment. No proper bile contents could be demonstrated. Frenzel regards it as premature to ascribe to the organ any other function than that of secreting a digestive ferment, though the complex and variable histology may suggest something more. The memoir is accompanied with a gorgeous coloured plate.

* SB. K. Akad. Wiss. Wien, xcii. (1885) pp. 7-12 (1 pl.).
† Nova Acta Leop. Carol. Acad., xlviii. (1886) pp. 81-296 (3 pls.).

Early Development of Loligo.*—The segmentation of the egg and the formation of the germinal layers of *Loligo Pealii* are described by Mr. A. T. Bruce.

The protoplasm of the egg segregates to one pole, forming a germinal disc, which is segmented throughout its thickness. It then becomes split into two layers of cells, the ectoderm and mesoderm; but along a line, the future long axis of the embryo, the ectoderm alone is present, and in the region of this line certain cells separate from the mesoderm, which from the spindle shape and oval nuclei are recognized as endoderm cells. As no nuclei were observed in the yolk, no endoderm cells are derived therefrom spontaneously. The mesoderm bands become two cells thick; the endoderm spreads, and soon the ectoderm and endoderm surround the whole yolk, whilst the mesoderm extends only half-way round. A slight prominence in the centre of the embryonic area is the first trace of the mantle, and at this stage the two mesoderm bands were no longer separated.

'Challenger' Cephalopoda.†—Mr. W. E. Hoyle's report on the Cephalopoda collected by the 'Challenger' is almost completely systematic in scope; when careful attention was given to the characters of the radula, whence it was hoped assistance might be derived which would be important in the limitation of the species, it was found "that in almost every radula each row of teeth differs a little from the one preceding it, and very frequently five, six, or even more rows must be examined before a given form repeats itself; two rows of teeth from the same specimen will often differ as much as two from different species." From this it follows that the majority of figures hitherto published of Cephalopod radulæ are quite useless for diagnostic purposes.

A new family of Amphitretidæ is formed for *Amphitretus pelagicus*, which is unique among Cephalopods in having the mantle fused with the siphon in the median line, so that there are two openings into the branchial cavity, one on either side. *Japetella* is remarkable for its gelatinous semi-transparent body, but, unfortunately, like a number of other 'Challenger' specimens brought up by the trawl, there is considerable uncertainty as to its real place of origin. *Promachoteuthis* is provisionally defined, as only one specimen of a single species is as yet known. A special report on *Spirula* is being prepared by Professor Huxley; ten new types are added to the genus *Sepia*. From the stomach of a shark there were taken fragments of a gladius, which, if correctly referred to the genus *Chiroteuthis*, indicates that that genus must attain to dimensions hitherto unsuspected; what can be pieced together of this fragmentary pen amounts to 78 cm. *Histiopsis* is a new type, intermediate between *Calliteuthis* and *Histioteuthis*. The remarkable larva described by Ray Lankester as *Procalistes Suhmii* is referred to the genus *Taonius*.

Very few pelagic Cephalopods were obtained by the 'Challenger'; this may be explained by the enormous activity of these animals, which can only be captured when the vessel is going at great speed, or when, in other words, it is difficult or impossible to use a tow-net; the investigation of the contents of the digestive tracts of predaceous birds, fishes, and Cetacea, will probably do much to increase our knowledge of these molluscs. Apart from the fact that *Bathyteuthis* and *Mastigoteuthis* have slender filiform tentacles with minute suckers, no structural features have been discovered, which will serve to distinguish a deep-sea form from a shallow-water one.

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 45–6.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xliv., 4to, London, 1886, 245 pp. and 37 pls.

New Gymnosomatous Pteropod.*—M. P. Pelseneer recognizes four families of known gymnosomatous Pteropods — Pneumodermatidæ for *Pneumodermon, Dexiobranchæa,* and *Spongiobranchæa;* Clionidæ for *Clione;* Halopsychidæ for *Halopsyche;* and Clionopsidæ for *Clionopsis.* The new genus—*Notobranchæa*—which he now describes, must be placed in the fifth family of Notobranchæidæ; in it the body is contracted behind, and presents only a dorsal branchia, formed by three crests, of which the dorsal alone is fringed. Anterior and posterior lobes of the foot long and narrow, the former free in their posterior two-thirds. *N. MacDonaldii* sp. n. was taken off Carolina, and measures 8 mm. in length. M. Pelseneer considers that the Gymnosomata have been derived from the Aplysians, and that the least specialized genus is *Dexiobranchæa,* with lateral branchiæ; *Pneumodermon* is greatly complicated by the posterior branchia having four crests radiating from the original ring; *Clionopsis* shows retrogression, and *Clione* is apparently derived from *Notobranchæa.*

Embryology of Prosobranch Gasteropods.†—Dr. J. P. McMurrich adds some additional facts to his previous contributions ‡ on the subject.

He finds corrosive sublimate and alcohol the best fluids for preservation. Perenyi's fluid caused excessive swelling and distortion of the eggs containing much yolk.

He describes the egg-capsules of *Fulgur carica, Fasciolaria tulipa, Purpura floridana,* and a species of *Crepidula.*

1. *The ovum and nutrition of the embryo.*—Each capsule of *Fulgur* contains 12 or 14 large eggs, imbedded in a large quantity of albuminous substance, and containing much yolk. The reactions of the albumen showed it to be a proteid. In the case of *Fulgur,* all the eggs develope; but such is not the case in the other forms, where only a few out of numerous eggs develope, the rest serving as food. This breaking down is not due to non-fertilization, but to the quantity of yolk being too small for the number of eggs. He traces a series of stages in the proportional number of eggs which develope, and concludes that some change in environment has rendered it desirable for the eggs to remain longer in the capsule than their ancestors did. He gives a summary of observations on this head.

2. *Segmentation and formation of germinal layers.*—At the earliest stage the polar globule, which is single in *Fulgur,* was already formed, and contained yolk-granules. The ovum elongates, divides transversely into two equal parts, through the polar pole. A second division gives four equal spheres. Then, at the polar pole, an aggregation takes place from each of these, which gets nipped off to form four micromeres, which are completely protoplasmic. No further division takes place in the macromeres, which gradually fuse; but new micromeres arise partly from these, and partly from the micromeres. At a certain stage a peculiar elevation takes place in three of the macromeres, which is coincident with the first appearance of the mesoderm, in the fourth macromere. Ultimately epibole becomes complete, except for the blastopore.

Then follow several pages devoted to *theoretical* questions. From the presence of a single polar body in *Fulgur,* Dr. McMurrich considers that the relative amount of protoplasm and yolk influence the formation of these bodies, which may explain their usual absence in Crustacea. After a brief review of the various modes of segmentation in the invertebrate phyla, he

* Bull. Sci. Dep. Nord, ix. (1886) No. 6. Cf. Ann. and Mag. Nat. Hist., xix. (1886) pp. 79–80.

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 403–45 (4 pls.).

‡ See this Journal, 1886, p. 583.

suggests that the segmentation of Platyhelmintha, Annelida, Mollusca, and Molluscoida can be referred to a common type. It follows that the regular segmentation occurring in certain forms in each of these groups is brought about secondarily by loss of yolk originally present.

3. *The velum.*—This organ is developed from paired ectodermic folds on the ventral surface, which meet neither dorsally nor ventrally. The author finds in many Gastropods, that the velum consists of a preoral band of strong cilia, and a postoral band of smaller cilia; and between the two an area clothed with fine cilia, continuous with those of the œsophagus; this arrangement is probably characteristic of Prosobranchs.

4. *Excretory organs.*—In *Fulgur* there is no "head-kidney," but the larval kidney consists of ectoderm cells with highly refractive contents, as in *Nassa*.

Paludina and *Bithynia* alone amongst Prosobranchs possess a "head-kidney" as well as a larval kidney. The secreting cells were probably originally part of a preoral velar area, and as they became more important they separated from it and eventually replaced the "head-kidney."

5. *Nervous system and sense-organs.*—The cerebral and pedal ganglia are developed in the usual way from paired ectodermic thickenings. The latter have no connection with the "byssus-gland" or "aquiferous pore" as has been stated by some authors.

The typical apical thickening, as the origin of cerebral ganglia in the ancestor of Annelida and Mollusca, or "Trochozoon," is not present in Prosobranchs; it is present in Pulmonata, but the development of marine forms has been abbreviated and thus has been lost.

At the end of each chapter a summary and discussion of the results of previous writers is given.

Typical Nervous System of Prosobranchs.*—M. E. L. Bouvier finds that the nervous system of Prosobranchs is characterized by a chiastoneurous visceral commissure, or one twisted in the figure of 8. It has its origin in the commissural ganglia and contains a subintestinal branch which arises from the left commissural ganglion and passes backwards from left to right under the œsophagus; it forms a subintestinal ganglion, and trends towards the heart on the right side of the body; there is also a supra-intestinal branch which arises from the right commissural ganglion, and passes from right to left, forming a supra-intestinal ganglion; it makes its way along the left side of the body to join the subintestinal branch. This is the typical arrangement, but it becomes much more complicated in a number of forms. As to these the author sketches the characters of a few of the more important and significant.

Lepidomenia hystrix.†—MM. Marion and A. Kowalevsky give an account of a new genus of Solenogastres or amphineural molluscs, which was found at a depth of 30 metres in the Gulf of Marseilles; a single individual was found in the calyx of a *Balanophyllia italica*, and was scarcely 0·002 m. long. It is allied to *Proneomenia* by its internal organization, but is strongly distinguished by a very original spicular investment; the body is entirely covered with strong spines, the bases of which are applied directly to the hypodermis, without the interposition of any cuticular mass, such as is found in *Proneomenia*. When examined under low powers the surface seems to be covered not by spines, but by imbricated scales; this appearance is due to the bases of insertion of the spines which are more apparent than their hyaline mass. The hypodermis is relatively rather thick, and the most numerous of its elements are prismatic cells with large nuclei;

* Comptes Rendus, ciii. (1886) pp. 1274–6. † Ibid., pp. 757–9.

scattered among these are large brown cells, which are probably glandular. In the posterior dorsal region the hypodermis is modified to form a small sensitive crypt, similar to that which is found in *Proneomenia*. The body-cavity is occupied by a fundamental connective tissue, similar to that which is found in various molluscs; below the pedal groove there is a larger sinus, and here the respiratory changes are effected by the currents set in motion by vibratile cilia; of the circulatory system, the heart alone is well differentiated; this is surrounded posteriorly by a large pericardium from which two simple nephridial tubes, surrounded by a secreting cellular mass, are given off. An anal cloaca is formed where these tubes unite in the region of the rectum. Though the animal was not sexually mature, it was clear that the generative apparatus was on the type of that of *Proneomenia*. There is a true radula with eight strong teeth, large salivary glands, and a small dorsal cæcum. The brain is large, and the lateral nerves immediately dilate into a small special ganglion; the two lateral bands are united by a transverse ganglionic commissure, and a strong commissure connects the two anterior pedal ganglia; no sublingual commissure could be made out.

'Challenger' Scaphopoda and Gastropoda.*—The Rev. A. B. Watson has a gigantic report on the Scaphopoda and Gastropoda collected by the 'Challenger'; there are in the collection about 1300 recognizable species, and some 400 indistinguishable forms. At 41 stations, whose depths range from 400 to 2650 fathoms, 89 old, 135 new species, and 46 indistinguishable forms were collected. On the whole, the collection is disappointing, but the methods of more recent dredging show that mechanical improvements may yet be introduced which will greatly extend our knowledge of deep-sea life. The author explains that the classification which he has adopted is not one of which he approves, but is the least objectionable he could find.

Mr. Watson remains of the opinion first expressed by him seven years ago, that there really are shallow and deep-water species and genera, though their bathymetric limits are not constant; temperature much more than depth is an important condition in molluscan life; great differences in depth and temperature form the barriers of distinct geographical provinces; but there are species whose distribution is universal. Though he does not desire to press negative evidence, Mr. Watson finds no trace, even in the oldest and most widely distributed species, of essential lasting and progressive change.

In an appendix the Marquis de Folin describes the Cœcidæ.

'Challenger' Marseniidæ.†—Dr. R. Bergh takes the opportunity given him by describing the few Marseniidæ collected by the 'Challenger' to write a valuable and compendious essay on the structure and characters of this family of Gastropods. A new genus, *Marseniopsis*, is described, which forms a remarkable link between the diclinous and the androgynous Marseniidæ, and prevents our splitting up the family. *M. pacifica* from Kerguelen and *M. Murrayi* from Marion Island, are the two new species of this interesting genus. The only other example of the family found by the 'Challenger' was *Marsenia dubia* sp. n.

'Challenger' Polyplacophora.‡—The report by Prof. H. C. Haddon on the few Chitons collected during the voyage of H.M.S. 'Challenger' deals

* Report of the Voyage of H.M.S. 'Challenger,' Monograph xlii., 4to, London, 1886, 756 pp., 3 pls.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xli., 4to, London, 1886, 24 pp. and 1 pl.

‡ Report of the Voyage of H.M.S. 'Challenger,' Monograph xliii. (1886) 56 pp. and 3 pls.

with the systematic aspect only, the anatomical report being deferred for the present. In his introductory remarks the author insists on the importance of distinguishing carefully local varieties, and recommends it as against indiscriminate formation of new species. About eighty specimens only were collected, which are referable to fifteen genera and thirty species, seven of which are here described for the first time.

Mouth-lobes of Lamellibranchs.*—Herr J. Thiele has examined the oral lobes in eighteen families of Lamellibranchs, and finds that in many cases they have so characteristic a structure as to be well adapted to be used, with other marks, as distinctive peculiarities.

They are invested in a single layer of ciliated epithelium, but the cells vary greatly in length; the long cilia pass through a distinct cuticular fringe. Beneath these there are goblet-cells. What appear to be sensory cells are to be found in depressions between the ridges, or on elevations of epithelium; they are always much scattered, and give off processes into the connective tissue. After describing the differences in these cells in various forms, the author commences his account of the connective tissue with a description of what obtains in *Mytilus*. Between the mucous cells are branched connective cells which contain "tubes" of intercellular substance; these are connected with a large blood-space which runs along the upper edge of the oral lobe, and is only shut off from the exterior by epithelium and connective-substance, the latter being not very compact; this blood-space may be regarded as a true vessel, it is probably arterial and corresponds to the tentacular artery of the Najades. Below the epithelium there is a structureless membrane which, on its inner side, contains considerable muscular and nervous bundles, generally arranged along the long axis of the oral lobe. The fibres which separately traverse the tissue are probably not to be regarded as muscles, but as connective-tissue cells, for the part which surrounds the nucleus often sends off irregular processes, and so marks them as spindle-cells. At the lower margin there are a quantity of cells which Flemming regards as small multicellular mucous glands; the author, however, has not been able to definitely make out efferent ducts. Along the line of fusion of the ridges with the tegumentary fold there are peculiar rods of modified connective substances, which in their relation to the staining reagents correspond to the so-called chitinous rods in the gills. After comparing other forms with *Mytilus*, the author resumes the results obtained by himself and other authors.

As to the physiology of these lobes, the first point to attempt to settle was the possibility of their having any function in relation to the ingestion of food. The arrangement of the cilia on the surface beset with ridges on the margin must produce a current which, when the oral lobes do not lie close to one another, must generally direct the firm particles to the margin. Direct experiment with Najades proved the importance of the oral lobes as directive organs. The use of the marginal currents appears to be to drive away the water from which the food has been obtained. The close relation to a large blood-vessel points also to a secondary respiratory function.

Further investigations are necessary before we can assure ourselves of the justice of Prof. Lovén's supposition that the labial tentacles of the adult Lamellibranch are the remains of the velum.

Morphology of Eye of Pectens.†—Prof. O. Bütschli directs attention to the hitherto unnoticed fact that in the eye of *Pecten jacobæus* the thin

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 239–72 (2 pls.).

† Festschrift Naturh.-Med. Ver. Heidelberg, 1886, pp. 175-80 (1 pl.).

peripheral margin of the layer of pigment-cells passes into the retina; the want of observation of this may be ascribed to the great delicacy of the cells in this region. Put generally, we find that the retina and pigment-layer form a closed optic vesicle, which, however, differs essentially from that of other molluscs in that the sensitive region is turned away from the light. This great difference appears to be easily explicable by the difference between the lenses of the two groups of molluscs. In molluscs other than *Pecten* the lens is a secretion-product formed in the interior of the optic vesicle, where it permanently or temporarily remains; in *Pecten*, and also in the Vertebrata, the cellular lens is formed outside the optic vesicle, and so the outer wall of the optic vesicle is turned towards it.

North Sea Mollusca.*—In the second part of the report on the Mollusca collected by the Norwegian North Sea Expedition Herr H. Friele describes the Pleurotomidæ, Cancellaria, and Brachiopoda; there were a number of species of *Bela*. *Asbjœrnsenia* is a new genus, which is placed before *Montacuta* and after *Philine*.

Molluscoida.

α. Tunicata.

The Salpa-chain.†—Mr. W. R. Brooks compares the development of the chain of *Salpa* to that of *Pyrosoma*.

He first describes briefly the development of the young *Pyrosoma*, and gives a detailed description of that of *Salpa*, the arrangement of the young *Salpæ* on the stolon, and the changes in position during growth. As in *Pyrosoma*, the young *Salpæ* are not produced by budding from the walls of the stolon, but arise by conversion of the segments of this structure into the bodies of the new organisms. But whereas in *Pyrosoma* there are only three or four young ones in successive stages of development, in *Salpa* there are many successive *sets*, each consisting of 50 to 100 individuals at the same stage. The stolon arises from the hæmal surface of the solitary *Salpa*, and consists of an outer wall of ectoderm and an inner endodermal tube, which communicates with the branchial sac of the parent, and arises from the floor of the ventral groove.

At first the young *Salpa*-chain is bilaterally symmetrical, but in the mature chain the individuals are placed in a rather complicated fashion, which arises from crowding and pressure. In reality there is a single series, each placed dorsum to venter, with the neural surface towards the base of the stolon, and the right sides of all on the right side of the stolon, so that the middle plane of symmetry coincides with the middle plane of the body of each *Salpa*.

By a rotation caused by crowding the complicated arrangement of the mature chain is brought about.

Mr. Brooks finds that horizontal sections are the only means of ascertaining the true relations, as each successive *Salpa* will be cut in a different plane.

The arrangement of the *Salpæ* to the stolon is given in detail.

Synascidians new to the French Coast.‡—M. A. Giard gives a notice of *Diazona hebridica* and *Distaplia rosea*, which appear to be new to the coast of France. M. Giard thinks that *Diazona* is a composite Clavelinid, and he points out that it approaches the simple Ascidians by the fact that

* Den Norske Nordhavs Expedition, 1876–8. xvi. Zoologi. Mollusca, ii. 4to., Christiania, 1886, 44 pp. and 5 pls. (Norwegian and English in parallel columns.)

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 451–73 (2 pls.).

‡ Comptes Rendus, ciii. (1886) pp. 755–7.

the ova are not incubated in the maternal organism, although he allows that this is by no means an essential character. The author does not agree with Della Valle in believing that there is any relationship between *Distaplia* and *Aplidium;* from a comparative study of the migratory buds and ova he comes to the conclusion that the former genus finds its closest allies in *Anchinia* and *Doliolum; Distaplia* is to *Anchinia* what the Diplosomidæ are to the Pyrosomatidæ—the fixed representatives of a pelagic form.

The free buds are true diblastulæ, comparable to the gemmiparous stolon of *Perophora*, which also arises at exactly the same anatomical point in each individual of the colony.

β. Polyzoa.

Metamorphosis of Bryozoa.*—M. J. Barrois thinks that in considering the metamorphosis of the Bryozoa we ought to distinguish two great types, one represented by *Phoronis* and one by *Pedicellina*. The former is characterized by the predominance of the ventral surface, which forms the whole of the body, and by the reduction of the dorsal surface to a terminal region; in the latter the aboral surface (or the cephalic end of the trochosphere) predominates, and extends above the whole oral (somatic) surface to form the whole of the integument of the adult, the somatic surface being pushed into the interior. He does not look upon what obtains in the Chilostomata as being really an intermediate condition; while not denying that the evagination of the internal sac of the larvæ of the Ectoprocta may be considered as the same thing as the evagination of the ventral tube of *Phoronis*, he notes that it does not play a determining part in the acquisition of the characters of the adult, and that it is not followed, as in *Phoronis* and *Rhabdopleura*, by the reduction of the whole of the aboral surface; this rather continues to form an umbrella.

Both types of development are derived from the trochosphere, the author withdrawing his previous comparison of Bryozoa to a rotifer fixed by its oral surface; that of most Bryozoa is due to the predominance of the cephalic and the indrawal of the somatic region; that of *Phoronis* (and perhaps also *Rhabdopleura*) to the predominance of the ventral face and the crowding of the whole of the dorsal surface (the preoral lobe and velum being here included) into a restricted portion of the terminal region. The Entoprocta are regarded as being the most primitive of the Bryozoa.

The conclusions of this memoir are based on the study of a number of different forms, amongst which are *Lepralia pallasiana*, *Bugula flabellata*, *Serialaria lendigera*, which is the most typical example of the tun-shaped larvæ, and *Pedicellina*. The theory of alternation of generation is altogether rejected.

New Family of Bryozoa.†—Dr. J. Jullien institutes the new family of *Costulidæ* for the *Cribrilina* of Gray; *Escharella arge* D'Orbigny may be regarded as the typical species; the seventeen recent and fossil genera of which it is composed are defined, and five new species (two new genera) are described.

Arthropoda.

Spermatogenesis of Arthropods.‡—Prof. G. Gilson has communicated a lengthy memoir in which some of his results on the spermatogenesis of Arthropods are set forth. After a careful review of the history and a dis-

* Ann. Sci. Nat., i. (1886) 194 pp. (4 pls.).
† Bull. Soc. Zool. France, xi. (1886) pp. 601–20 (4 pls.).
‡ La Cellule, i. pp. 1–188 (8 pls.). See this Journal, *ante*, p. 69.

cussion of the all too-abundant nomenclature, Gilson reports his observations on the development of sperms in certain Myriopods, Insects, Arachnids, and Crustaceans. In doing so the author observes the following order:—(1) The steps in the evolution of the mother-cells, that is to say, the series of cellular multiplications which end in a last generation of sperm cells which are directly transformed into sperms; (2) the formation of the spermatozoid, characterized by phenomena of internal differentiation occurring within the protoplasm and the nucleus of the sperm cell; (3) the special phenomena concerned with the liberation of the ripe sperms. *Primordial metrocytes* give rise to *metrocytes* or actual mother-cells (spermatogonia, &c., of authors), and these form *spermatic cells* (spermatocytes), which develop directly into sperms. Whether the spermatocytes appear as external buds on the metrocyte or by internal endogenous division there, they are throughout to be regarded as homologous. A more extended notice may be deferred till Gilson's further results on Crustaceans come to hand.

Nervous System of Insects and Spiders and Remarks on Phrynus.*—*Acridium* and *Thyridopteryx* served Mr. A. T. Bruce for his study of the nervous system in insects.

The supra-œsophageal ganglion of insects and Arachnids is distinctly double. Each ganglion of the ventral chain is closely invested by mesoblast cells forming a "perineurium," which originates as a median ingrowth along the ventral mid-line. The perineurium also invests the transverse and longitudinal commissures, and each of two adjacent ganglia. These latter are at first solid masses of cells, the central portion of which breaks down and becomes "punktsubstanz"; by extension laterally and longitudinally, this gives rise to the commissures.

The supra-œsophageal ganglion has exactly the same structure, and is divided into an anterior and posterior division, separated by perineurium. The "brain" therefore of insects and spiders consists of two pairs of ganglia serially homologous with the ganglia of the ventral chain. The anterior division belongs to the antennal somite, and innervates the antennæ of insects and the rostrum of spiders; both these are special homologues with the first antennæ of Crustacea.

The posterior division belongs to the somite of the upper lip, which is a paired structure in the two insects studied, so that the labrum of insects and spiders is homologous with the second antennæ of Crustacea.

The circum-œsophageal commissures in insects are formed by a backward extension of the posterior division of the ganglion, and the nerves coming off from it really belong to the ganglia.

Some observations were made on the embryos of *Phrynus;* the resemblance of the ventral surface of the adult to that of *Limulus* is noted. There is a curved process on the inner side of the coxal joint of the last thoracic appendage, corresponding to that of *Limulus.* Paired structures are present resembling the chilaria. Each of the three last appendages bear episterna.

On the coxal joint of fourth appendage there is a sense-organ; the epidermic cells are here columnar, and are continued outwards as filaments, several of which enter a single pair, which is the external part of the sense-organ.

Function of Palps of Myriopods and Spiders.†—M. F. Plateau finds that in the chilopodous Myriopoda, as in mandibulate insects, the palps are not indispensable for capturing prey, recognizing food, or introducing it

* Johns-Hopkins Univ. Circulars, vi. (1886) p. 47.
† Bull. Soc. Zool. France, xi. (1886) pp. 512–30.

into the buccal cavity. Unmutilated chilopods use their palps as a first pair of limbs to turn the prey in the directions most suitable to their being cut by the mandibles. The palps are also used to clean the joints of the antennæ, and sometimes of the feet.

In female spiders the palps do not seem to have any more importance than the reduced limbs, and specimens deprived of these organs, spin their threads quite normally, and take and suck insects in exactly the same manner as uninjured examples do.

If the author's conclusions are just, it would seem that the palps of mandibulate insects, female spiders, and Myriopods, are degenerate cephalic appendages which have lost their primitive size and function, and have become almost useless organs, of which their possessor may be deprived without suffering any inconvenience.

a. Insecta.

Vesicating Insects.*—M. H. Beauregard continues his researches on vesicating insects or Meloidæ, of which previous reports have been given. (1) *The circulatory and respiratory systems* are first briefly discussed, but do not differ in any important point from those of other insects. (2) The *nervous system* is also simply referred to, as Beauregard's results were essentially confirmatory of the careful investigations of Audouin, Brandt, Ratzburg, and Erichson. (3) The *reproductive system* of the male is then discussed in detail, with special reference to the common Cantharid (*Cantharis vesicatoria*). (*a*) The *testes* are almost spherical bodies, colourless or slightly yellow, composed of a large number of elongated tubules opening centrally into a common reservoir, with which the end of the vasa deferentia is associated. (*b*) The *vasa deferentia* consist of an epididymis portion, lined with large cylindrical cells and clad externally by a muscular tunic. This is followed by a larger cylindrical tube, which serves as a sperm reservoir. It opens into the enlarged urn-shaped anterior extremity of (*c*) the *ejaculatory duct*, which forms for the rest of its course a muscular tube. There are three pairs of (*d*) *accessory glands* which open into the swollen anterior urn of the ejaculatory duct. The insertion and structure of these glands is then described. Omitting the histological details, the first pair consist of scorpioid tubes with a mucous secreting function, and never acting as sperm-reservoirs. The short cæca which form the second pair also contain a sort of granular mucus. The third pair consist of long necklace-like tubes with very thin walls. They alone function as seminal reservoirs, and are at the same time the seat of the production of the active principle cantharidine. Nine different forms are then discussed. In most there are three accessory glands, but *Sitaris* has only two, and *Epicauta* four. Among those with three pairs, *Zonitis* and *Mylabrum* are somewhat divergent.

Biology of Chrysomelidæ.†—Herr Weise points out that much still remains to be done on the biology of the Chrysomelidæ; from the facts cited by him with regard to the habits of the larvæ, it is clear that the subject is one of much interest, and that there are considerable differences to be observed in various forms.

Anatomy and Physiology of Tongue of Bee.‡—Herr P. F. Breithaupt has chiefly investigated the tongue in species of *Bombus* where the parts

* Journ. Anat. et Physiol., xxii. (1886) pp. 524–48 (1 pl.).
† Naturforscher, xix. (1886) pp. 510–11.
‡ Arch. f. Naturgesch., cii. (1886) pp. 47–112 (2 pls.).

are much larger and less liable to variation than in *Apis mellifica;* for the former, he used as staining reagent acid carmine, but for the latter, borax carmine or hæmatoxylin. After a general account of the structure of the mouth-parts, the author proceeds to describe their finer anatomy.

The tongue is described as having a groove with its edges directed downwards, which extends as a closed canal along the whole length of the chitinous rod, and only posteriorly widens out into the lingual groove; the small-spoonlike process is nothing more than the continuation of the chitinous rod which projects over the lingual mantle; the outer membrane of the latter is highly chitinized and covered with the long anteriorly directed setæ, which were called by Wolff collecting hairs; these are 1/5 mm. long, terminate in a fine tip, and are inserted in regularly arranged whorls; these last form horny arches which support the walls of the tongue. The hairs are longest and strongest on the dorsal side of the tongue, and decrease in length and strength as they pass backwards; at the tip they form a branch which is very well adapted to take up the honey. The length of the whole tongue is, in workers of *Apis mellifica* about 6·5 mm., in drones and queens about one-half of that, the shortness, of course, being correlated with their mode of life; the tongue varies in breadth, and is longer behind than in front; in *Apis* it is from 0·045–0·085 mm. broad anteriorly, and 0·16–0·18 mm. posteriorly.

In the chapter on the mentum, the paraglossæ are described as scale-like structures which form the inner sheath of the tongue; on their upper surface they are very horny and beset with tactile hairs, while below they are formed of delicate membrane; the glands formed by the side of the tongue in *Bombus* are wanting in *Apis*, and this fact, together with the small size of the system, leads us to think that they have no important function; as no chemical investigation of their secretion was possible, it is not easy to say what that function is, but their position leads us to suppose that they must oil the neighbouring parts and diminish the friction of the chitinous organs.

From the few observations the author was able to make, he concludes that in bees the sense of smell and taste are not physiologically separated. The musculature and mechanism of the apparatus of the labium has been very closely investigated, and is carefully described; with regard to the suctorial act, the experiments which were made seem to show that there are two possible paths by which the honey may be taken up; one is by the great suctorial tube of the proboscis, when the bee only licks the sugar with its tongue, and the other is by the capillary tube of the chitinous rod which would take up the last remains of the sugar. The bee, then, only licks so long as there is sufficient fluid; when this begins to fail, and the honey can only be reached by the outermost tip of the tongue, the tube is put into use.

Wall-bee and its Parasites.*—Herr K. Lampert has studied the life-history and parasites of the wall-bee (*Chalicodoma muraria*). In the case of this solitary bee, there are, as is well-known, no special workers. The female builds the many-celled stony nest on the warm side of rough-hewn walls, stores it with honey, lays the eggs, and shuts them up. If the weather is good as many as 16 cells may be built. In northern countries there is only one annual brood. The larvæ pass into the pupa-stage in June and July, spin a glassy skin, and remain for a variable period quiescent. The young bee does not get out till spring, however, and some

* Jahreshefte d. Vereins f. Vaterl. Naturk. in Württ., 1886. Cf. Naturforscher, xx. (1887) pp. 15–6.

damping of their prison walls seems almost necessary before they can make their escape.

Before the eggs are shut in, however, some lurking parasites have utilized the nest for their brood also. From larval intruders found in the nest, Lampert reared no fewer than nine different parasites,—Hymenoptera, Coleoptera, and Diptera. The bee *Stelis nasuta* is one of the commonest of these thieves, and sometimes four larvæ were found in one cell. It is probable that these devour first the food and then the wall-bee larvæ for which it was intended. The wasp *Monodontomerus nitidus* is an equally common thief; sometimes 36 were found in one cell. Lampert thinks that the mother inserts the eggs through the wall of the nest. These were found sometimes within the cocoon of the wall-bee, sometimes within that of a Stelis intruder. Three Diptera pursue the same tactics e. g. *Argyromœba sinuata*. The most dangerous foes, however, are the Coleopterous *Trichodes alvearius* and *Tr. apiarius*, the larvæ of which sometimes bore from one cell to another; *Meloë erythrocnemus* was also found.

Scales of Lepidoptera.*—Herr E. Hase discusses peculiar scale structures in Lepidoptera. He notes first the tire-spur (Schienensporn), a secondary sexual character, aiding in the mutual attraction of the sexes. In the spur there lies a gland which appears to moisten the olfactory organ in the antennæ. The spur is absent in specially well-developed feelers in the male, and on the plump wingless females of Geometræ, and only occurs in both sexes of Heteroceræ when they are both capable of flight, and that at the same time of day. Special male scales occur, sometimes hidden and covered with a fragrant secretion, and apparently attractive. In the male of Ornithoptera, &c., a peculiar form of wing is associated with the presence of these scales. The fragrance is scattered by long mobile tufts of scale-hairs, or rubbed off by the so-called rubbing spots (Reibeflecke). Other hard scales on both sexes of the Indian genus *Hypsa* appear to produce a shrill sound, as otherwise occurs in the male of *Thecophore fovea* (Rogenhofer) and of the Indian *Caristes membranacea*.

Larva of Smerinthus and its Food-plants.†—Mr. E. B. Poulton details his new experiments on this subject undertaken in order to throw more light on the two questions raised in his previous paper,‡ viz.—(1) are larval tendencies towards certain colours transmitted? and (2) is it the colour, and not the substance, of the leaf eaten, that influences the colour of the larva? To both these questions his numerous experiments point to an answer in the affirmative.

The second question was tested by sewing together the edges of a folded leaf, so that only one surface, upper or lower, was exposed, and therefore eaten by the larva. The author gives details of his experiments with five batches of larvæ raised from eggs which had been laid by moths bred in captivity.

As to the occasional occurrence of yellow larvæ on leaves of *Salix viminalis*, various evidence points to the following explanation:—the larvæ are only affected by that part of the plant in close contact with them; the tint of mature larval life is a resultant of conflicting tints of various periods of larval life; the ultimate predominance of any tint being due to the relative proportion of larval life passed in such a tinted environment. The strong influence for white, which the apple leaf exerts, is due to the fact of the large size of the leaf, so that the larva even when large can still remain

* Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte Berlin, 1886. Cf. Biol. Centralbl., vi. (1886) p. 640, and Naturforscher, xix. (1886) p. 510.

† Proc. Roy. Soc., xl. (1886) pp. 135–73. ‡ See this Journal, 1886, p. 429.

on the leaf, and does not migrate to the stem till a later period than in the case of larvæ feeding on smaller leaves, such as *Salix*. The paper ends in a summary, in tabular form, of the evidence derived from the various experiments.

Tracheal Gills of Pupæ of Simulidæ.*—Dr. Vogler has had his attention directed to some pupæ which he found on various water-plants in the Rhine, which were remarkable for the trachea-like shining tubes which were developed at the anterior end of the body; in the more common species they were proportionately short and thick, and in the other very long and fine. The anterior end of the body of these pupæ is blunt, and forms an almost circular surface, the centre of which is occupied by the pronotum; in the space between it and the case there are two spindle-shaped gill-tubes, which are so bent as together to form a circle; at about the middle of one of these basal tubes there are given off six almost cylindrical and equally long tubes, while a true trachea provided with a distinct spiral opens below. A stigmatic ring connects the short process of the basal tube with the trachea; the latter is so distinct as to seem to lie outside the body; it then suddenly bends inwards, and passes to a tracheal limb of the body.

The apparatus consists, therefore, of two similar—right and left—halves, which are not in direct connection with one another; each half consists of blindly ending tubes which form a circularly closed cavity which is connected with the body-tracheæ by a short connecting tube. There is no essential difference between the form with short and that with long tubes.

The tubes are filled with air so long as they remain connected with the animal, but when the case is abandoned they become filled with water, and form a home for infusoria, &c. Each tube has a thin and apparently structureless chitinous investment, on which is a thin granular or dotted layer; but it is not certain whether the dots are the optical expression of pores.

Wings of Diptera.†—Dr. E. Adolph has systematized the descriptive terminology of the veins and folds in the wings of Diptera, and has endeavoured to trace the derivation of the manifold forms from a typical plan. His patient and elaborate work is illustrated by figures of about fifty different wings in which the concave and convex veins and folds are clearly represented by lines of different colour and construction. The memoir will doubtless be of service in facilitating the labours of specialists in this department of entomology.

Life-history of Aphides.‡—Dr. H. F. Kessler has followed the life-history of several species of Aphis, including especially *A. padi*, *A. euonymi*, *A. viburni*, *A. mali*, *A. pyri*, and *A. sambuci*. He has shown that the genus Aphis contains forms which exhibit essentially the same history as that demonstrated in some *Tetraneura*, *Schizoneura*, and *Pemphigus* species. At the end of spring, as Lichtenstein noted, they leave the plant which they originally infest, and return to it at the end of summer or in autumn. They survive the winter as ova, and begin their activity with the commencement of the vegetation in spring. The author questions the correctness of the supposition that the Aphides as such survive the winter, along with, or even without the presence of ova. In *Aphis padi* the following three phases in the cycle are distinguished:—(1) The spring phase on *Prunus padus*, including the ancestral form, with its immediate progeny,

* MT. Schweizer. Entomol. Gesell., vii. (1886) pp. 277–82.
† Nova Acta Leop.-Carol. Acad., xlvii. (1885) pp. 269–314 (4 pls.).
‡ Ibid., pp. 117–140 (1 pl.).

which are both winged and wingless, and their descendants, which are all equipped with wings; (2) the summer phase on some unknown plant, beginning with a wingless, and ending with a winged form; (3) the autumn phase again on *Prunus padus*, including the sexual forms and the egg from which the ancestor of next year's brood is developed in the following spring.

Orthezia cataphracta.*—Dr. J. H. List has prepared a monograph of the female of this Coccid, which is found leading a subterranean life in the Alps; it has generally an oval form, but varies considerably, and there is much difference between young and older examples. It is 3 mm. long, and 2·5 mm. broad, while the marsupium or egg-sack projects 1·5 to 2 mm. backwards. The external integument is wax-like; there is a dorsal carapace of varying form, the exact relations of which are fully detailed, and there is also a ventral carapace; the whole has, in living specimens, a white colour, and when magnified, is seen to be superficially striated, the striæ running symmetrically on the right and left halves; it is composed of a body closely resembling wax, and fuses at about 80° C., but in young individuals at 83° C. When this is removed by needles or dissolved off by chloroform, the internal chitinous integument becomes apparent; in it areas similar to those of the outer integument are to be detected; the outer is beset with setæ which may attain a length of about 19 μ, are hollow, open to the exterior, and formed of chitin; under each seta a canal leads to the internal surface of the carapace, and this widens out to a funnel internally; these canals serve to carry the wax-like mass that forms the outer integument. In addition to these setæ there are spine-setæ, which are also hollow organs, but are closed, and end by a sharp point; they are placed within small chitinous papillæ; they are in connection with a canal which leads through the integument. Other processes may be called chitinous papillæ, and they are best developed in the region of the marsupium. In the hypodermis unicellular glands are to be found, and these are specially abundant on the chitinous funnel of the anus. There are also in the hypodermis some larger cells, which are covered by the dorsal and ventral muscles; these are surrounded by a distinct membrane, and clearly go to form the adipose tissue.

The author gives a detailed account of the muscular system, and makes the following observations on the structure of the tissue. If a bundle is observed in 0·5 per cent. salt solution it is seen to have a fine longitudinal striation, and to be of a fibrillar character; the whole bundle is surrounded by the sarcolemma, which is swollen up at a number of points, where long oval nuclei are to be seen; between the fibrils there is sarcoplasm, in which nuclei are still to be made out. Sections of muscles hardened in alcohol or sublimate-picric acid allow us to study the composition of the part; by the action of the hardening material the bundles are somewhat separated from one another. Typical transversely striated muscular bundles are also to be found.

A thoracic may be distinguished from an abdominal tracheal plexus; in the former there are tracheal vesicles from each of which a primary trunk arises; the disposition of the secondary branches and of the transverse commissures is described in detail; the abdominal plexus has seven pairs of stigmatic orifices, but they are much smaller than the two thoracic stigmata. The whole system is completely open, or is on the holopneustic plan of Palmén.

The mouth-parts are described in detail, and it is striking to observe

* Zeitschr. f. Wiss. Zool., xlv. (1886) pp. 1–86 (6 pls.).

how different they are in *Orthezia cataphracta* from the same parts as described by Mr. E. L. Mark for *O. characias* Bosc (= *O. urticæ* L.). They are followed by a description of the digestive tract. With regard to the Malpighian vessels, the author commences at their point of insertion into the mid-gut; the common tube divides into two, and these two tubes again divide into two branches which extend from the third to the eleventh segment. Each pair forms a loop on either side, and the two unite in the middle line; all four vessels lie at first above the rectum. With regard to their finer structure, it is noted that there is externally a transparent homogeneous membrane in which no cell-nuclei can be detected; in each vessel there are two rows of cells, each of which in profile appears to be six-sided. The cells are surrounded by a distinct membrane, and contain bright spheres of various sizes; the nucleus appears after staining; it is spheroidal or ellipsoidal, and has a distinct membrane with a nucleolus which appears to the author to be an elongated thickening of the nuclear membrane. Transverse sections through a vessel reveal the presence of a central canal; the vessels are very richly supplied with tracheæ which are mostly provided by the abdominal plexus.

With regard to the manner in which the insect takes in its fluid food, the author states that he was unable to convince himself of the presence of any pumping apparatus, and he thinks that the fluid enters by capillary action due to the canals of the bundles of setæ. The arrangement and histology of the salivary glands are described.

The little-known nervous system of the Coccidæ reminds the author of the great resemblance between its ventral medulla and that of the Myzostomata; in the supra-œsophageal ganglion he was able to observe unipolar ganglion-cells, the largest of which were 17 μ long, and had a transverse diameter of 11 μ; two or three nuclei were to be seen in them, no distinct membrane was to be detected, and no suggestions can be made as to their function. The antennæ are remarkable for the variations in the number of their joints, and that even in one and the same individual, where the left antennæ may have eight, and the right seven joints; another individual had five or six joints.

In an elaborate description of the generative apparatus it is pointed out that from the yolk-spheres formed by the fusion of the epithelial cells there is developed, after the degeneration of the nuclei of the epithelial cells, a unicellular structure provided with a large nucleus—the mature yolk-cell.

β. Myriopoda.

Special Sensory Organs of Myriopods.*—Dr. E. Tömösváry describes a peculiar sense-organ which he has observed in species of *Lithobius;* it is found in front of the eyes at the lateral margin of the head, where it has the form of an infundibuliform depression, at the base of which there is a small round orifice. The inner surface is clothed with ganglion-cells connected with the optic nerve. In *Polyxenus lagurus* the organ lies on either side of the head, and has three round orifices with projecting edges; in each of these there is a proportionately very long hair, connected at its base with a ganglion; the hair is movable in various directions. A very different sense-organ is found in species of *Pauropus* at the ends of their feelers between the tentacles; this may be conical, or be surrounded by two movable semilunar plates; these organs are so small as to require high magnification for their detection. Special sense-organs are also to be detected in species of *Glomeris;* in *Scutigera* they are at the base of the

* Mathemat. u. Naturwiss. Berichte aus Ungarn, i. (1883) pp. 324–6.

inner part of the lower maxillary palp. These organs are probably useful in detecting variations in the conditions of the atmosphere.

Mechanism of Respiration in Myriopods.*—In the Myriopods there are no special movements in the respiratory apparatus, able to produce an indraught and outdraught of air, as in insects. M. J. Chalande has made experiments on some of the Myriopods, and comes to the conclusion that inspiration and expiration of air are due to contraction and expansion of the dorsal vessel. The blood passing along the sinuses in the body bathes the tracheæ, and accentuates at each contraction the curve of the tracheæ; thus there is an alternating increase and decrease of the total capacity of the respiratory apparatus, during repose. This is increased during motion by the action of the muscles of the legs, and by the movement of the alimentary tract during digestion. Moreover a lowering of the temperature acts on respiration by a diminution in the contractions of the dorsal vessel.

Structure of Spinning-glands of Geophilidæ.†—Dr. E. Tömösváry finds that the spinning-glands of *Geophilus* have the ordinary constitution of arthropod dermal glands—gland, duct, and tunica propria of the gland; each compound gland ordinarily opens by a special compound gland; and these are themselves found between the space formed by the lateral fold of the pleura and between the muscles of the last body-segment; they are spherical or pyriform in shape, and consist of a number of tubular simple glands of the value of cells; in each a cell-membrane, granular cell-contents, and a cell-nucleus are to be made out. The efferent duct is proportionately long and rather wide, and has a pretty thick hyaline wall; the tunica propria is a fine hyaline membrane which may be regarded as the inner membrane of the matrix of the chitinous layer. It may be concluded that the spinning-glands are compound dorsal glands which are derived from the ectoderm, and have undergone invagination. They are very like the poison-glands of Chilopods, but their spinning function is inferred from the fact that it is their fluid secretion—which hardens on exposure to air—that forms the body which cements together the ova and spermatozoa.

Phosphorescence of Geophilus.‡—M. Macé has studied the phosphorescence of a species which appears to be *Geophilus simplex;* the phenomenon seemed to him to be due to a colourless liquid which is very slightly viscous and dries rapidly; it is not excreted from the anal orifice, but from the whole of the ventral surface of the body; the light is a little less strong than that of *Lampyris* and seems to be of a green colour. At the commencement of the observation the whole of the back was phosphorescent, but at the sides were the two lines of greatest intensity; after a short time the light began to fade from the back, and then from the side; for some minutes a longitudinal row of bright dots shone at the sides. These, so far as the author could judge from the darkness in which the observations were necessarily carried on, were situated near the stigmatic orifices.

The explanation of Dubois does not seem to apply to these Myriopods; like certain *Chætopteri* and Polynoids described by Panceri, the light seems to be due to a mucus secreted by the skin, and transverse sections show that, in the region of the stigmata, there are masses of large hypodermic cells which are probably the secreting agents.

* Comptes Rendus, civ. (1887) pp. 126–7.
† Mathemat. u. Naturwiss. Berichte aus Ungarn, ii. (1884) pp. 441–6 (1 pl.).
‡ Comptes Rendus, ciii. (1886) pp. 1273–4.

Respiratory Organ of Scutigeridæ.* — Dr. E. Tömösváry describes the respiratory organ of the Scutigeridæ as being much flattened, about 1 mm. long and 1·5 mm. broad, with the form of two kidneys fused along their inner edge; the stigmatic orifice leads into a respiratory cavity, the upper and lower surface of which are formed by basal membrane, the respiratory tubes arising only from the anterior and lateral margins; these tracheæ are very fine and hyaline, and gradually but regularly narrow to their blind end; they never anastomose with one another along their course, they are quite homogeneous, and show no indication of spiral filaments. There is no peritoneal investment, such as is found in other Tracheata; or, if it is present, it is modified. The glandular appearance of the tubes, which has led some authors to ascribe a glandular function to these organs, is explained as being due to the presence of wandered cell-nuclei of the tracheal matrix, which are found between the tubes.

δ. Arachnida.

Non-nucleated Blastoderm-cells.†—Korottneff, Grassi, and others have described amœboid cells becoming blastoderm-cells, but at certain stages without nuclei. Herr W. Schimkiewitsch has noted the same phenomenon in the development of spider ova. Since he had traced the non-nucleated cells, however, from the division of the germinal vesicle and surrounding protoplasm, he, of course doubted the possibility of the nucleus being absent. He treated the sections, preserved in Kleinenberg's fluid, with a weak solution of ammonia, and stained them with borax-carmine, with the result that in the densely stained elements, rounded unstained corpuscles could be detected, *like empty nuclei*. This he compares with results of other observers, and suggests that the unstained bodies are true nuclei, from which the chromatic substance has been passed into the surrounding protoplasm. He regards it, then, as probable that all the so-called non-nucleated blastoderm-cells are simply instances of the temporary disappearance of the chromatin nuclear substance.

Embryology of Spiders.‡—Herr J. Morin communicates a brief notice of his researches on the embryology of spiders. His investigations were based upon Theridion, Pholcus, Drassus, and Lycosa, but refer especially to the first of these.

(*a*) After being laid, the ovum of Theridion exhibits two egg-envelopes, the chorion and the vitelline membrane. In the centre lies the germinal vesicle, surrounded by finely granular protoplasm giving off strands into the surrounding yolk. In two hours the nucleus divides into two, four, and eight segments, but the yolk remains still undivided. When the eight-cell stage is reached, however, the yolk also divides into eight pyramids, with a central segmentation-cavity. The segments multiply regularly and each contains a single nucleus. The nuclei move towards the surface, and when the number of segments is 128, the outer nucleated portions are separated from the internal yolk portions, which then flow together again.

(*b*) Soon afterwards the embryo is seen to consist of three kinds of cell, (1) the layer surrounding the whole (ectoderm), (2) a number of cells separated from the former and lying immediately beneath it on the ventral surface (mesoderm), and (3) several cells of similar origin which have penetrated into the yolk (endoderm). In Theridion there is no "primitive cumulus" such as is formed in Pholcus, Drassus, &c. This cumulus is an

* Mathemat. u. Naturwiss. Berichte aus Ungarn, i. (1883) pp. 175-80 (1 pl.).
† Arch. Slav. de Biol., ii. (1886) pp. 26–7.
‡ Biol. Centralbl., vi. (1887) pp. 658–63.

accumulation of mesoderm cells, which gradually separates from the main mass, and pushes the passive ectoderm outwards before it. The component cells become large and round and extend dorsally, eventually forming blood-corpuscles.

(*c*) The triangular germinal disc becomes distinctly marked. The apex or posterior lobe represents the rudiment of the abdomen, the base or anterior lobe that of the cephalothorax. Transverse furrows form the segments and the appendages appear as papilla-like protrusions of ectoderm, into which the mesoderm also penetrates. The mesoderm is also segmented, and the body-cavity appears as a cleft in each segment. Large round cells near the somites form the blood-corpuscles. The ganglia begin to appear as paired thickenings of ectoderm. Salensky's observation as to the two semicircular folds in the head-lobes is confirmed. Soon the halves of the germinal disc, and also the mesoderm somites begin to grow dorsally and eventually meet above. The incipient blood-corpuscles collect in a dorsal abdominal strand, and this is surrounded by mesoderm which thus forms the heart. The stomodæum and proctodæum are formed as usual. A few days before liberation, the scattered endoderm cells in the yolk separate themselves from the latter at the internal ends of stomodæum and proctodæum, forming two tubes which grow together. These come into association with the rudiments of the liver lobes. The respiratory sacs appear as two ectodermic invaginations at the base of the first pair of abdominal appendages, which become their external coverings. The second pair of abdominal appendages disappear. The third and fourth pair form the spinning papillæ as Salensky noted. Ectodermic invaginations form the glands. The Malpighian tubes develope from two evaginations from the proctodæum.

Anatomy and Physiology of Glyciphagidæ.*—M. P. Mégnin finds that the small cylindrical prolongation which has been described by MM. Fumouze and Robin at the end of the abdomen of the female *Glyciphagus* is an exclusively copulatory organ; before copulation it is a tube open to the exterior and communicating with a spherical pouch, which is a true spermatic reservoir; after the act the opening of the tube becomes obliterated, the pouch disappears, and the ova are laid by the subthoracic genital organ, which has no other function.

At times of starvation the young octopod *Glyciphagi* undergo a protoplasmic liquefaction of all the organs contained in the limbs and trunk; the gelatinous material is collected in the cavity of the thorax, and its spherical mass becomes surrounded by a chitinous envelope. So long as the circumstances persist, which led to this condition, so long it persists, and the creature is like a grain of dust at the mercy of the wind; put under, or reaching more suitable conditions, development proceeds. Here, we have the explanation of the sudden appearance of myriads of mites which seem to have appeared spontaneously.

Anatomy of the Tyroglyphidæ.†—Dr. A. Nalepa in his second essay on the anatomy of the Tyroglyphidæ, states that the chitinous covering is generally thin and extensile; where it is thicker it is friable and striated; the hypodermis is a plexus of ramified cells with rare nuclei, and the connective tissue has a similar structure. In the latter there is a quantity of fat and carbonate of lime deposited, and here and there are colossal fat-cells. The oil-glands are dermal organs, developed in shallow pits of the epiblast on either side of the proctodæum; they are invested in a cubical epithelium which secretes an oily fat.

* Comptes Rendus, ciii. (1886) pp. 1276–8.

† SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 116–67 (3 pls.).

The maxillæ, labrum, and labium fuse to form a buccal tube, and the cheliceræ are innervated from the central ganglion; the stomach has two lateral cæca; there is no muscular tissue, and the œsophagus has no epithelium; there is a suctorial apparatus in the pharynx; two tubular Malpighian vessels open into the rectum and have a granular excretion rich in uric acid.

The male generative apparatus consists of two testes, two vasa deferentia. and accessory glands; the penis varies considerably in form, and offers a good means for distinguishing species; it consists of a groove, to which is articulated a plate perforated by the ductus ejaculatorius; its supporting plates are movably connected with the integument, and on either side are two suctorial pouches with two suckers each. The females have two ovaries with long ducts, a vagina, and a receptaculum seminis, which is connected with the ovaries by two short canals, and opens to the exterior by a retro-anal orifice. The spermatozoa are immobile rounded cells; the gonads are developed from two cell-aggregates placed on either side of the proctodæum, and of, apparently, epiblastic origin; the receptaculum is an invagination of the hypodermal tissue which lies behind the anus. In addition to the retractors of the suckers, there are others which move the lower supporting plate.

The central nervous system consists of a cerebral ganglion and a broad ventral ganglionic plate; the two are intimately connected, and there is only a narrow canal between them for the passage of the œsophagus; the ganglion sends off nerves to the cheliceræ and maxillary palps, and the plate innervates the maxillæ, feet, and abdomen; the ganglionic cells do not vary much in size; the nerves are finely striated.

At the first ecdysis, the fourth pair of feet are developed from the imaginal discs, which underlie the third pair of the six-legged larvæ; it is not correct to think that the organs of the larvæ liquefy before each ecdysis. *Trichodactylus* is sometimes ovoviviparous, and its ova are attached by a stalk, the oral ovarian pole being always directed upwards.

ϵ. Crustacea.

Embryology of Alpheus and other Crustacea, and the development of the Compound Eye.*—Mr. H. F. Herrick studied the development in *Alpheus*, *Hippia*, *Palæmonites*, and other decapod crustacea.

The origin of the ovarian egg in *Alpheus* and in *Palinurus* resembles that in the lobster. The fertile egg of *Alpheus minus* has a large segmentation nucleus, which early becomes an ill-defined mass of chromatin thread, and is imbedded in a central area of protoplasm, which forms the usual network inclosing the yolk-spherules.

After two or four parts have arisen by division, the chromatin of each part becomes concentrated at various points, giving rise to a swarm of small nuclei, each with a distinct cell-wall and granular contents. In the next stage observed, the yolks had undergone partial segmentation into pyramids.

In one species of *Alpheus* this pyramidal structure is partly lost; the superficial cells are widely separated, and lie slightly below the surface, and some are sunk in the yolk. They apparently form part of the endoderm. In the next stage a complete blastoderm is formed and a small invagination takes place; but the cells of the endoderm are not well-defined, they send processes into the yolk and at the bottom of the

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 42-4 (1 fig.).

archenteron, multiply and send into the yolk nuclei, from which new endoderm cells are formed.

The archenteron is obscured, and is never included within the yolk. There is a great accumulation of nuclei at the side of the blastopore, just below the blastoderm, and these become mesoderm cells, which also appear in the abdominal region later on. Thus, the mesoderm arises partly from the superficial and partly from the invaginated ectoderm.

After the appearance of the nauplius stage, the development passes on much in the same way as in the lobster. The development of the eye has been traced through all the later stages in *Alpheus* and *Palæmonites*.

At the nauplius stage the brain and optic ganglia form a continuous mass of ectoderm cells arising by proliferation of the superficial ectoderm. There is no invaginated cavity such as Kingsley has described. The optic ganglia nearly meet above the brain; the superficial ectoderm cells elongate, and from these cells alone the eye is formed. These divide transversely, so as to form a series of radial strings. Separating these from the underlying yolk, or, in some cases mesoderm, is a basal membrane which soon becomes pigmented. The pigment cells elongate radially outwards, and become the retinulæ, and each ommatidium of *Alpheus*, *Penæus*, and the other decapods examined, possesses *seven* retinulæ.

The outermost cells of the strings separate slightly from the inner ones, and form the corneal hypodermis which secretes the cornea. Below these follows a stratum of more elongated cells, the retinophoræ; these are in groups of four, with white granular matter between each; this is a secretion product, which will form the crystalline cones. The space between the cornea and retinophoræ is filled by undifferentiated ectoderm cells. Between and around the retinulæ, a chitinous framework becomes developed, which is continued below the basal membrane.

The primitive ommatidium does not resemble an ocellus; nor does the development of the compound eye favour the supposition that it has arisen by a gradual fusion of ocelli.

Sense of Touch in Astacus.*—Mr. G. L. Gulland describes his experiments and the results derived therefrom, as to the structure and distribution of the setæ on *Astacus*. These setæ are either *sensory*, in which case the lumen communicates with the canal through the integument at the end of which the seta is articulated; or they are simply *fringing setæ*, when this lumen is closed, and no nerve can be traced into it. Of the sensory setæ—auditory, olfactory, or tactile—he discusses only the last, which are most conveniently seen in the abdominal swimmerets. They are long, simple, cylindrical at the base and hollow, with granules in the lumen—the remains of a "papilla" of the hypodermis, which assist, after a moult, in the formation of a new seta. In the fringing setæ, the lumen is closed near the proximal end by a chitinous ingrowth but in *Thysanopoda* this closure is absent. A detailed account is given of the distribution of the tactile setæ on the appendages and body of *Astacus*.

The nerve-endings were studied in the great chela. They are nearly cylindrical, surrounded by a membrane, in direct continuity with the surrounding connective tissue. Within the membrane is granular protoplasm, in which are a number of nuclei resembling those of ganglion-cells. At the proximal end of this tactile organ the nerve-fibres break up and become continuous with its protoplasm. There are generally two or three nerve-end organs to each tuft of setæ. Each nerve-fibre, after leaving the end-organ, passes through the hypodermis, and breaks up, sending a branch into each

* Proc. R. Phys. Soc. Edin., cxv. (1885-6) pp. 151-79 (2 pls.).

seta, but does not pass up the whole length of the lumen. There is a glandular structure amongst the nerve-endings of the great claw, which resembles a salivary gland. As to the ganglion in the claw, it is not a reflex centre, but is probably sensory, collecting the impressions from the end-organs, and transmitting them to the central nervous system.

The author traces out a genealogy of the setæ. Starting with a primitive seta, allied to a fringing seta, but not so flattened, it stood over a wide canal; the lumen was not closed; there was a single row of bristles on each side, and a nerve-ending attached to its base. From this seta the fringing setæ were derived in one direction, and the sensory setæ along another line; these were at first primary tactile setæ, which became modified in three directions, to give rise to auditory, olfactory, and tactile setæ.

Embryology of Schizopods.*—Herr J. Nusbaum gives a preliminary sketch of the early stages in the development of *Mysis Chameleo*. Before segmentation begins the egg exhibits a large quantity of nutritive yolk, and at the formative pole an aggregation of finely granular protoplasm with a large round nucleus. A thin layer of homogeneous protoplasm extends over the whole surface of the yolk. The nucleus divides and the peripheral half multiplies into the nuclei of blastoderm disc, while the other remains under the egg-membrane. In the middle of the disc there are some large cells dividing tangentially. Some of the other cells divide radially, and an accumulation of cells is gradually formed beneath the blastoderm. These Nusbaum calls "vitellophagous," because they subsequently absorb the yolk-material into which they penetrate.

The margins of the blastoderm gradually grow round the yolk. The thickened disc consists of cylindrical and cubical cells, and lies on the ventral surface of the posterior part of the ovum. As it widens, an unpaired caudal portion, two lateral ventral strands, and the anterior head-lobes gradually become differentiated.

At the posterior caudal disc a shallow invagination is formed, and the cells of the floor of the invaginated portion multiply rapidly and form a solid mass of endoderm cells. The mesoderm appears as two solid strands of cells, arising from the ectoderm, and lying along the thickened ventral strands above referred to. They multiply rapidly and grow inwards. At the time when the rudimentary limbs are appearing the mesoderm strands exhibit three corresponding thickenings. Somatic and splanchnic layers are afterwards differentiated. The origin of the germinal layers is compared with that of insects, &c. The endoderm forms the paired rudiment of the liver, and a portion of the midgut. On each side of the ventral strand, two symmetrical, disc-like ectodermic thickenings appear at an early stage. They form two oval sacs, lined by long pyramidal cells, and containing a homogeneous substance. They represent the saddle-shaped organs of *Oniscus*, *Ligia oceanica*, and the dorsal organ of *Asellus* and *Orchestia*.

'Challenger' Stomatopoda.†—Prof. W. K. Brooks thinks that the primitive stomatopod was characterized by the possession of small, subcylindrical eyes, an acutely pointed rostrum, a smooth hind-body, a short wide smooth carapace, very small antennary scales and uropods, and a telson which was wider than long. This primitive form is represented to-day by *Protosquilla*, from which the various genera have diverged. Most near to it stand *Gonodactylus*, *Pseudosquilla*, and *Coronida;* the last leads to *Lysiosquilla* and *Squilla*.

* Biol. Centralbl., vi. (1887) pp. 663–7.

† Report of the Voyage of H.M.S. 'Challenger,' Monograph xlv., 4to, London, 1886, 116 pp. and 16 pls.

In the study of this group very special attention must be given to the larvæ: the larval life is so long and forms such a considerable part of the total life of each individual, while the larvæ are so perfectly developed, and their relations to their environment so complex, that there are about as many species of larva as of adults, and the specific differences between them are fully as pronounced; the differences between different genera of larvæ are often greater than those between the genera of adults. The fully-grown larvæ are in no sense embryonic and generalized: save for the absence of reproductive organs they are just as highly organized as the mature forms. Using the special names which have been applied to them, Prof. Brooks makes a classificatory table of the larvæ which "exactly matches the one given for the adult Stomatopoda."

Of the fifteen species of adults collected by the 'Challenger' eight are new; the genus *Gonodactylus* is broken up into *Gonodactylus* (s. str.), *Protosquilla*, and *Coronida* gg. nn. Among the material there is sufficient for a full history of the *Alima*-larva: this is one of the largest of known pelagic larvæ, and leads an active life, pursuing and capturing with the greatest rapidity the Copepods and other small Crustacea which form the chief part of its food: Mr. Faxon has reared a *Squilla* from an *Alima*, and it appears that all Squillæ have *Alima*-larvæ. The author thinks that it can be shown conclusively that the *Alima* is an *Erichthus* which has become accelerated in development; the larva of the most primitive of the true *Squillæ* was probably an *Erichthus*-like *Alima*. If this view be correct the larvæ of all other genera of Stomatopods must be looked for among the Erichthi and Squilleriehthi; here the series of larvæ are so complete and transitional forms are so numerous that it is very difficult to divide it into minor groups. The larva of the new genus *Coronida* appears to be very primitive and synthetic: for it the provisional name of *Erichthalmia synthetica* is proposed. All the larvæ found by the 'Challenger' are described in detail.

Isopoda of the 'Lightning,' 'Porcupine,' and 'Valorous' Expeditions.*—The Revs. A. M. Norman and T. R. R. Stebbing have published the first part of their report on the Isopoda of these British expeditions, in which they treat of the Apseudidæ, Tanaidæ, and Anthuridæ. Apart from the Serolidæ the most interesting of the abyssal Isopoda are the Munnidæ and Munniopsidæ, which are furnished with antennæ and legs of extraordinary length and delicacy of structure; unfortunately the free use of sieves in washing the ooze entirely mutilated such specimens as were collected by these British expeditions. In the present report G. O. Sars' arrangement of tribes and families is adopted.

Of the Apseudidæ *Sphyrapus* is a new genus, in which the animal is less elongated than its allies, there is no scale to the lower antennæ, and the peræon-segment unites with the carapace. Under the Tanaidæ reference is made to the interesting changes which are to be observed as following on moults, and a consideration of Mr. Faxon's observations leads to the suggestion that the enormous grasping-organs which so encroach on the mouth-organs as to deprive *Leptochelia* and *Anceus* of taking food, and which appear after the moult which precedes sexual intercourse, are moulted off after the discharge of the sexual functions; if they are not, their possessor must die of starvation. *Alactamais* and *Tanaella* are new genera; the latter appear to be most closely allied to *Strongylura*, and the former has a marsupial pouch composed of eight lamellæ, which are attached to the first four free segments of the body.

* Trans. Zool. Soc. Lond., xii. (1886) pp. 77–141 (12 pls.).

Of the Anthuridæ there are four new genera—*Cyathura*, *Anthelura*, *Hyssura*, and *Calathura*.

In a postscript reference is made to works published since 1884; with regard to the species which forms the basis of Prof. Claus's memoir—*Apseudes latreillii*—the authors point out that it is certainly not that species as ordinarily understood, and they propose for it the name of *A. hastifrons;* two very important papers have also been published by Prof. Sars.

Diagnostic tables accompany the descriptions of the families and genera.

New Isopoda.*—Mr. C. Bovallius, in two essays on new or imperfectly known Isopoda, describes eight new species from various localities; with these, as with the previously named species which he re-describes, he gives, when he can, descriptions of males, ovigerous and virgin females and larvæ.

Asellidæ.†—Mr. C. Bovallius, in his notes on the Asellidæ, institutes three new generic names with the object of getting more uniformity in the system; these are *Iamna*, *Iathrippa*, and *Iais*. A useful analytical table of the genera is given. *Iais haryeii* is the only species; the old ones are carefully described and their synonymy fully given.

Amphipods.‡—Dr. H. Blanc has described seventeen Amphipod forms found in the Bay of Kiel. The memoir also contains a histological description of the calceoli or peculiarly shaped sensory organs found on the antennæ of many Amphipods. These were regarded by Sars, Leydig, and others as olfactory organs, but the author is apparently inclined to attribute to them an auditory function. The olfactory rods generally distributed on the anterior antennæ are also discussed.

Amphipoda Synopidea.§—Mr. C. Bovallius institutes a new tribe of Amphipoda Synopidea, for the forms intermediate between the Gammaridæ and the Hyperiidea; it is divisible into the three families of the Synopidæ, which are most closely related to the Gammarids, the Trischizostomatidæ, and the Hyperiopsidæ. The constituent species, among which are two new forms of *Synopia*, are very carefully described.

Forgotten Genera of Amphipoda.‖—Mr. C. Bovallius has some notes on *Lanceola* Say, which is not, as has been supposed, identical with *Hyperia* or *Vibilia;* of this rare form five new species are now described; on *Daira* Milne-Edwards, which is not identical with *Dairinia* of Dana, who changed the name in consequence of *Daira* being preoccupied, but it is apparently identical with *Paraphronima* of Claus; *Clydonia* Dana is identical with *Tyro* M.-E., and as the latter name has priority it must be restored; five new species are described. The distinctive characters of the genus *Tauria* Dana are pointed out.

Apus and Branchipus.¶—Herr Fickert points out as the result of his observations that *Branchipus* may be found alone, but *Apus* only where the former is also present. *Branchipus* is in fact the principal prey of *Apus*. Kept together for a night in conditions where escape is impossible, the weaker fall victims to the stronger. The nimble and transparent character

* Bihang Svenska Vet. Akad. Handlingar, x. (1885) 32 pp. and 5 pls.; xi. (1886) 19 pp. and 2 pls.
† Bihang Svenska Vet. Akad. Handlingar, xi. (1886) 54 pp.
‡ Nova Acta Leop.-Carol Acad., xlvii. (1885) pp. 37–104 (5 pls.).
§ Nova Acta R. Soc. Upsal., iii. (1886) 36 pp. and 3 pls.
‖ Bihang Svenska Vet. Akad. Handlingar, x. (1885) 18 pp. (1 pl.).
¶ Naturforscher, xx. (1887) pp. 5–6.

of *Branchipus* enable it, however, to survive in the open water in spite of its formidable enemy.

New Genus of Parasitic Copepoda.* —M. E. Cann has found in the tissue of the Synascidian *Morchellium argus*, a new genus of parasitic Copepods, for which he proposes the name of *Aplastoma brevicauda*; it is most remarkable on account of the reduction of the buccal armature, the mandibles, maxillæ, and first pair of maxillipeds being lost; the second pair of maxillipeds seems to be represented by two triarticulate appendages, but even these have acquired a locomotor function; the adult female is 1½ mm. long, and the body consists of nine rings, four of which go to the short tail. Among the ascidiicolous forms the new genus seems to be most nearly allied to *Cryptopodus flavus*, but that species, as described by M. Hesse, has simple multiarticulate limbs, and two pairs of buccal appendages; in the considerable reduction of its abdominal region and the modification of the appendages of the fifth thoracic somite of the female, it approaches *Entercola*, but it cannot be placed with either of these two generic types.

The Podostomata.†—Prof. A. S. Packard proposes the term Podostomata for the group formed by the orders Merostomata (with the suborders Xiphosura, Synziphosura and Eurypterida) and Trilobita; they may be defined as marine arthropods in which the cephalic (*Limulus*) or cephalothoracic (Trilobites) appendages are in the form of legs, which usually end in chelæ, and have the basal joints spiny so as to aid in the retention and partial mastication of the food. No functional antennæ. Eyes both simple and compound. Respiration branchial. Brain supplying nerves to the eye alone, the nerves to the cephalic or cephalothoracic appendages originating from an œsophageal ring and the ventral cord ensheathed by a ventral arterial system. Highly developed coxal glands with no external opening in the adult.

The class differs from the Arachnida in having no functional cheliceræ ("mandibles") or pedipalps ("maxillæ") in the cephalic appendages, but bearing a minute pair of ungues, and in the absence of urinary tubes. They differ from the Crustacea in the lack of functional antennæ, in the mouth-parts, in the compound eyes having no rods or cover, in the distribution of the cerebral nerves, and in the possession of an arterial coat enveloping the central nervous cord.

Crustacea of the Norwegian North Sea Expedition.‡—In the second part of his report on the North Sea Crustacea Prof. G. O. Sars enumerates the 337 species collected, and discusses their geographical distribution; there are notes on a few; sixty-four in all are new, and of these thirty-eight are Amphipods.

Vermes.

a. Annelida.

Structure and Development of the Generative Organs of Earthworms.§—Dr. R. S. Bergh deals with the much-vexed question of the structure and development of the generative organs of earthworms; in his historical introduction he refers to the now well-known discovery of Hering, but he omits to notice that a description and figure of the generative

* Comptes Rendus, ciii. (1886) pp. 525–7.

† Amer. Natural., xx. (1886) pp. 1069–76.

‡ Den Norske Nordhavs-Expedition, 1876–8, xv. Zoologi, Crustacea ii., 4to, Christiania, 1886, 96 pp., 1 map. (Norwegian and English in parallel columns.)

§ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 303–32 (1 pl.).

parts of the earthworm consonant with Hering's account was in 1870 given by the late Prof. Rolleston in his 'Forms of Animal Life'—that is, ten years before Blomfield (not Bloomfield) and fifteen years before Vejdovsky. As Dr. Bergh finds much to correct or add to in the work of previous observers it will be necessary to give a detailed account of the present paper.

In all the species of *Lumbrici* examined by him there are normally two pairs of testes in the ninth and tenth and a pair of ovaries in the twelfth segment; the testes vary in form in different species; the organs taken by Vaillant, Perrier, and Beddard for the testes of *Perichæta* are the vesiculæ seminales; the two pairs of white spheres noticed, but not correctly understood, by Horst are really the testes. The ovaries appear to be sufficiently well known.

The ovaries and testes are parenchymatous organs, consisting of a thin cortex of peritoneum and an internal compact mass of germinal cells; Dr. Bergh has been able to detect a line of demarcation between cœlomic epithelial cells of the ordinary kind and those which build up the substance of the testes; the differences are most apparent in the nuclei, for those of the germinal mass are much clearer, larger, and rounded, while they stain less easily, and are not homogeneous, but have a very distinct plexiform protoplasmic framework. Much the same account applies to the histological characters of the ovary. The gonads are the sole part of the generative apparatus that are laid down during the life within the cocoon.

With regard to the nomenclature of what may be indifferently called the seminal reservoirs, the author suggests that the paired appendages shall be called the seminal vesicles, and the median unpaired part the seminal capsule. The simplest condition is found in *Lumbricus turgidus*, *fœtidus*, and three other species which Eisen unites under the name of *Allolobophora*; in these the median capsule is completely wanting, and the seminal infundibula are quite uncovered and freely lie in the cœlom. In these species there are four seminal vesicles on either side—each testicular segment having two pairs. In *Lumbricus* (s. str.), e.g. *L. terrestris*, the second of the four vesicles is wanting from either side, the anterior testicular segment has two pairs of outgrowths, and the hinder only one, while there is a median seminal capsule; this last is due to a fine horizontal membrane which divides each of the segmental cavities into a larger upper and a smaller lower division, and the cavity of the capsule is therefore a part of the cœlom which has been cut off. The vesicles and capsule form reservoirs in which the spermatozoa mature, but it is not yet known how the cells which break off from the testes make their way into them.

Blomfield has correctly stated that the vesicles are finely camerate organs, and in this they differ from the capsule, the cavity of which is quite simple. With regard to the same author's acceptation of Prof. Lankester's suggestion that the seminal vesicles arise as pocket-like outgrowths of the side walls of the rosettes of the seminal infundibula, Dr. Bergh somewhat strongly says "die Figur giebt nur die Lankester'sche Phantasie, aber keineswegs die Natur wieder." Dr. Bergh has had no difficulty in assuring himself that the seminal vesicles arise quite independently of the seminal infundibula; by the study of suitable sections, he has seen that the vesicles arise from thickenings and invagination of septa 8–9, 9–10, and 10–11; the outer epithelium and the groundwork of connective tissue arise from the peritoneum of one side of the septa; the peritoneum of the other side invaginates and forms the canal with its enlargement, while from the fundamental membrane of the septa the muscular fibres and the vessels grow into the vesicle. Though he has not been able to follow

the history of the median capsule, he is certain that the vesicles arise earlier than and independently of it.

The receptacula ovorum correspond in function and mode of development to the reservoirs; they are not simple vesicles, but are camerated; they arise independently of the ovidncal infundibula.

The efferent genital ducts are next described and discussed, and there does not seem to be one fact to oppose the theory of their general homology with nephridia; the seminal pouches appear to be tegumentary glands modified for a special function, and to have absolutely nothing to do with segmental organs.

Anatomy and Histology of Branchiobdella varians.*—The object of Dr. W. Voigt is to add some histological details to Dorner's well-known memoir on this worm. With a view to determine the chemical characters of the cuticle, observations were made on various worms, and it was found that the cuticular substance of worms gives a different result after treatment with caustic potash to that which obtains with the chitin of Arthropods; and it must not yet be definitely stated that the cuticle of worms contains chitin. The cuticle of *Branchiobdella* consists of thin fibres crossing one another at right angles; there are macropores, but no micropores in it, and the former serve as the orifices of unicellular dermal glands; these pores are much smaller than those of the earthworm. The results of experiments on the contractility of the fibres explain the thinness and frequent loss of the cuticle in such forms as *Hirudo*, for here the extraordinary contractility of the body-wall acts on the system of fibres and produces considerable tension.

The hypodermis and circular musculature of *Branchiobdella* are intimately fused, and in the body-segments separated by an intermediate space from the longitudinal musculature; the hypodermis consists of simple cells set against one another like tubes of epithelium, and of unicellular glands, the contents of which are cleared up by the addition of dilute acetic acid. Below the hypodermis there is a membrane formed of the two lamellæ, which is the cause of the peculiar grouping of the glands between the circular muscles and of the so-called fenestrated appearance of the dermo-muscular tube. Some slight corrections are made in Dorner's account of the unicellular glands; in the seventh and eighth segments the nerves supplying the glands were observed to swell up at their ends into a ganglion from which nerve-rannles were sent to the several groups of glands.

The circular muscles are separated from one another by about their own diameter; no difference in their number could be detected by the author between the two varieties of the species, *parasita* and *hexodonta*; the longitudinal muscle is only slightly broken up into separate muscular bands; each muscle-cell is the length of a segment. In addition to those already described by Dorner there are two systems of smaller muscles, one of which runs parallel to the longitudinal muscles in each segment, and so serves to curve it on the contraction of the animal; the other lies beneath the longitudinal musculature, and, as it takes a diagonal direction, acts in the screw-like bendings of the body. The muscles are surrounded by a delicate sarcolemma and an envelope of connective tissue.

Dorner failed to note that blood circulates round the intestine, a blood-sinus surrounding the tube from end to end; in the dorsal and in the ventral middle lines this widens out to a distinct vascular trunk. In young forms the blood is corpuscular, but in the adult it is often yellowish or reddish, and there are no free cellular elements in it.

* Arb. Zool.-Zoot. Inst. Würzburg, viii. (1886) pp. 102–28 (1 pl.).

The whole of the digestive tract is, from the second segment to the anus, clothed internally by a simple epithelial layer, and this is certainly ciliated; below it is a nucleated membrane, which serves as a tunica propria, and also forms the inner wall of the blood-sinus; externally to this is a similar membrane, and the two are connected by rare filaments of connective tissue. Outside the muscular layer in some segments of the body there are the chloragogue cells, which are attached by a few processes to the outer wall of the blood-sinus, an arrangement which has not been observed in other Annulates.

Priapulidæ from Cape Horn.*—M. J. de Guerne reports that fourteen Priapulids were obtained by the mission to Cape Horn; of these, one is doubtful, two belong to *Priapulus tuberculatospinosus* obtained by Sir J. Ross, and the remainder to a new species—*Priapuloides australis;* it is much like the northern form *P. typicus*, but is distinguished by its smoother proboscis, and the larger development of its branchial appendages. The author gives a short account of its structural characters, and points out that it affords an interesting example of the presence in south-polar regions of forms which are almost identical with northern species.

β. Nemathelminthes.

Strongylus arnfieldi and S. tetracanthus.† — Dr. T. S. Cobbold describes the morphology of the hood and its rays of *Strongylus arnfieldi*, as well as the position of the vulva, and the structure of the embryo, contrasting them with those of allied forms.

The author's observations on the four-spined *Strongylus* show:—(1) The eggs are expelled from the parent in a state of fine yolk-cleavage. (2) The embryos are formed after egg-expulsion, and in a few days escape from their envelopes, undergoing a primary change of skin in the moist earth during warm weather. (3) Thereafter they live many weeks as rhabditiform nematoids. (4) In all likelihood an intermediary host is unnecessary. (5) The rhabditiform larvæ are passively transferred to their equine bearer either with fresh-cut fodder or whilst the animals are grazing. (6) Transferred to the intestinal canal they enter the walls of the cæcum and colon, encyst themselves, and undergo change of skin. (7) Their presence in the intestinal walls is associated with certain pathological conditions, frequently fatal to the bearer. (8) Ordinarily the young worms perforate their cysts and immigrate to the lumen of the intestine; indications of sex appear at this the Trichonema-stage. (9) They next form cocoons by the agglutination of vegetable débris within the intestine, and undergo a third ecdysis with intestinal metamorphosis. (10) The formation of the internal sexual organs and the completion of the definite form is accomplished within the colon of the host.

New Nematoid.‡—Prof. R. Leuckart states that during the larval stage of *Cecidomyia pini*, a nematoid worm, which calls to mind *Sphærularia*, is to be found in its cœlom; the name of *Asconema gibbosum* may be given to this new form. In addition to the peculiarities of the generative apparatus, the enteric tract, which has neither mouth nor anus, is remarkable for not forming a tube, but a solid cord formed of large cells rich in granules, which calls to mind the so-called cell-body of *Mermis albicans;* the ends of the cord are attached to the body-wall; the rudiment of a pharynx can be

* Comptes Rendus, ciii. (1886) pp. 760–2.
† Journ. Linn. Soc. Lond. (Zool.), xix. (1886) pp. 284–93 (1 pl.).
‡ Zool. Anzeig., ix. (1886) pp. 744–6; and Ber. Verhandl. Sächs. Gesell. Leipzig. 1886 (1887) pp. 356–65.

made out. Sexual reproduction is of course effected externally to the Cecidomyiæ, and after it the males die down, while the females, if they have the opportunity, make their way into the Cecidomyiæ larvæ, where they undergo a further change—they grow and the cells of their vagina increase in size to such an extent that they project from the genital orifice. As they continue to grow they press on the enteron, which they cause to lose its primitive structure, and to take on the cord-like disposition already described.

Helminthocecidiæ.*—Dr. F. Löw commences with the description of six new species of these gall-making Nematoids, two of which should be of especial interest to botanists, as they are the first galls which have been described in mosses. The second portion of the memoir deals with advances in our knowledge of species already described.

γ. Platyhelminthes.

Helminthological Observations.†—Dr. O. v. Linstow, in another communication with this now familiar title, gives an account of his investigations into the life-history of *Angiostomum nigrovenosum*. The ova of the hermaphrodite form found in the lungs of *Rana fusca*, contain the completely developed embryo; these have the integument very thin, are 0·13 mm. long and 0·6 mm. broad; on the eggs passing into the water they escape and grow rapidly; on the fourth day mature males begin to be observed, and on the eleventh, embryos were seen in the females, where a pair are found in a cuticular tube, although, just as in *Angiostomum entomelas* and *A. macrostomum*, there were primitively eight to ten eggs. The history of development and the embryos themselves are exactly the same in the three species.

After some notes on *Oxysoma brevicaudatum*, *Oxyuris ovocostata* sp. n. is described from the rectum of the larva of *Cetonia aurata*; *Distomum validum* is a new species 17 mm. long, from the stomach of an unstated species of dolphin; in connection with it a useful *résumé* is given of our knowledge of the dermomuscular tubes of the Trematoda; in this new species the subcuticula and the layer in which the circular and longitudinal muscles run is of an elastic-fibrous nature; this appears to be wanting in *Distoma* with delicate bodies, and to be limited to large species with proportionately stout cortical layers and well-developed muscles.

The rare *Distomum spiculator*, from the stomach of *Mus decumanus*, was very correctly described by Dujardin, to whose account Dr. von Linstow makes some additions.

Cysticercus tæniæ uncinatæ is a new cysticercus from the cœlom of the coleopterous *Silpha lævigata*, which agrees in its mode of development with *Urocystis prolifer*; but it is to be noted that the author objects to the formation of new and various genera of *Cysticercus*, as all are but stages in the development of *Tænia*. Dr. von Linstow repeats the essential parts of his discovery of the intermediate host of *Ascaris lumbricoides*, to which we have already drawn attention.‡

Distomum ingens.§—Prof. R. Moniez describes a new species of *Distomum*, and has some remarks on the comparative anatomy and histology of Trematodes. The new species is appropriately called *ingens*, as it is 6 cm. long, 2 cm. wide, and 1·5 cm. thick in its hinder region; the ova

* Verhandl. Zool.-Bot. Gesell. Wien, 1885, pp. 471–6. See Bot. Centralbl., xxviii. (1886) pp. 107–8.

† Arch. f. Naturgesch., lii. (1886) pp. 113–38 (4 pls.).

‡ See this Journal, 1886, p. 989.

§ Bull. Soc. Zool. France, xi. (1886) pp. 531–43 (1 pl.).

measure 38 by 23 μ. There is no indication of the origin of this remarkable form, which appears to be most closely allied to *D. personatum*.

Some of the results of M. Poirier as to the histology of the nervous system are traversed, the connective lamellæ which were said to embrace it not being apparent to M. Moniez; a careful description of the course of the nerves is given; some of the ganglion-cells are stated to attain the size of 50 by 30 μ; it is suggested that in some Trematodes we have a primitive arrangement of the nervous system. The parenchyma is regarded as being formed of a connective tissue with more or less close bars, the liquid which fills the interspaces coagulating under the influence of reagents; it is this coagulated matter which has given rise to the false interpretation of cells filled with protoplasm and touching one another; the justice of this criticism may be seen by a careful study of sections of the common fluke.

Nervous System of Tape-worms.*—As the results of his investigation of the central nervous system of *Tæniæ*, Herr G. Joseph notes—(1) that the two cerebral ganglia are in many cases (*T. transversalis*, *T. rophalocera*, hare) connected, not by a single dorsal commissure, but by two, separated by matrix and muscle-processes; (2) that each cerebral ganglion is triple, consisting of a median and two smaller (dorsal and ventral) ganglia, separated by muscle processes, as is best seen in *T. crassicollis*; (3) that in the bladder-worm, before the evagination of the hooks, the central system exhibits six equatorial ganglionic masses, which afterwards form a nerve-ring by the growth of bipolar processes.

Syndesmis.†—M. P. François makes some corrections in the account given by Mr. Silliman in 1881 of *Syndesmis*, a new Turbellarian; it is not ectoparasitic, but is found in abundance in the intestine of *Strongylocentrotus lividus*; the cilia of the epidermic cells are of the same size on the dorsal and ventral surfaces, and not larger below; the muscular system is formed by a system of well-developed dorsoventral fibres, and a few poorly developed longitudinal muscles in the anterior ventral region. There is no body-cavity; the digestive apparatus is more complex than has been supposed, but there are not a large number of testes, but only a pair, though these are provided with cæcal appendages; the uterus contains not one egg, but an ovoid shell which contains from two to thirteen eggs. The author corrects various errors as to the details of the female generative apparatus, into which he thinks that Mr. Silliman has fallen, but he agrees with his predecessor in the view that *Syndesmis* represents an intermediate form between the Trematoda and the Turbellaria. On account of its habitat he proposes to call it *S. echinorum*.

δ. Incertæ Sedis.

Studies on Rotatoria.‡—Dr. C. Zelinka describes two new species of the genus *Callidina*, *C. symbiotica* and *C. leitgebii*, which are found living on *Radula complanata*, *Frullania dilatata*, and other Hepaticæ; they are not true parasites, but "free space-parasites," dependent with the moss for rain and dew; they are widely distributed through Germany and Austria. Their anterior end is suddenly retracted and slowly extended, their movement is leech-like, and swimming is only rarely to be observed. Sixteen longitudinal folds are to be found on the back and sides, but are absent from the ventral surface. The matrix of the cuticle is a syncytial hypodermis.

* Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) p. 733.

† Comptes Rendus, ciii. (1886) pp. 752–4.

‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 396–506 (4 pls.).

The musculature is divided into a dermomuscular tube and muscles of the body-cavity; the former consists of a wide-meshed plexus of band-like longitudinal and circular muscles, which exhibit a division into primitive fibrils and posterior pieces; the longitudinal muscles are branched. The muscles of the body-cavity have their origin in the skin, and are either inserted into the segments of the body or into internal parts; they consist of contractile fibre-cells with homogeneous cortex and plasmatic axis, and they act more energetically than the dermal muscles. The cilia of the wheel-organ are separated on each hemisphere by a circular groove; in the lower circlet there are cilia which are directed towards the mouth. The buccal cavity is infundibuliform, and passes into a laterally compressed œsophagus. The wheel-organ is withdrawn by three homogeneous muscular fibres. From a study of this organ it is clear that, for a cilium to produce its effect the return must be slower than the blow or beating movement; the buccal cavity is able to divide into two cavities, the dorsal of which effects the indrawing, and the ventral, the removal of the corpuscles suspended in the water.

The terminal portion of the proboscis is beset with active cilia which are protected by two hyaline membranes; it contains a ganglion which is connected with the cerebrum by two strong nerves, and supports sensory cells surrounded by supporting cells. These last are processes of the hypodermis, which is itself connected with the hypodermis of the wheel-organ by a broad plasmatic band; the hypodermis is thickened above the ganglion.

The foot does not contain any of the organs specially belonging to the trunk, such as the enteric or excretory organs, but is in direct connection with the cœlom. The glands in it consist of four rows of uninuclear gland-cells, and an unpaired piece to which the rows are attached. The pharynx consists of two jaws with the proper musculature, and an elastic membrane which bounds the apparatus anteriorly; the dental formula is $\frac{2}{3}$. Two dorsal uninuclear and three ventral multinuclear salivary glands surround the pharynx; the œsophagus has a dorsal gland, and the stomach or chyle-intestine three pancreatic glands, which consist of a thick syncytial tube with numerous cell-nuclei, and a richly ciliated cuticle towards the lumen. It is attached to the dorsal integument by connective-tissue fibres, and is closed at its end by a muscular sphincter; the rectum has great powers of enlargement.

The central portion of the nervous system is an elongated pyriform cerebrum, the dotted substance of which lies in the centre surrounded by closely appressed nerve-cells; the peripheral nerves are sharply distinguished into groups for the anterior end and for the trunk. At the base of the tentacles and at the origin of the tentacular nerves there are several rounded cells; two nerve-fibres are stretched between the bases of the tentacle and the ganglion of the proboscis. There are two pairs of trunk-nerves, and these are finely granular.

The excretory organ consists of the contractile bladder, the ducts, and the ciliated lobes; in front of the opening into the bladder the tubes are constricted, and this arrangement prevents the return of fluid on the contraction of the bladder.

Males were never observed; the female generative organs are yolk-glands provided with highly granular and very bright large nuclei, which appear to be separated from the smaller germarium by a membrane; the ovum, consequently, appears to be nourished by a process of diosmosis. The whole organ is surrounded by a nucleated membrane; in the ripe condition the vitellarium and germarium form a syncytium, but in the un-

developed state the yolk-gland is formed of distinct cells; ordinarily only one egg is developed, and one gonad is ripe before the other.

Tornaria and Balanoglossus.*—Mr. G. B. Haldeman describes a Tornaria occurring on the Atlantic coast of America. It resembles that described by Metschnikoff, in being opaque, having eye-spots, and having the pore of the water-vessel on the left side.

The transformation of this larva was traced out, and the young *Balanoglossus* is only one-half the size of the Tornaria. It appears probable that it is the young of *B. Brooksii*. The author considers the homology between the water-vessels in this larva and in Bipinnaria to be true, and as justifying Metschnikoff's view of the relationship between the Enteropneusta and Echinodermata. But whether Tornaria or Bateson's larva (*B. kowalevskii*) is to be considered as more nearly representing an ancestral type, there is still the possibility that each may possess certain phylogenetic characters that have become obsolete in the other.

Echinodermata.

Holothurioidea of the 'Blake' Expeditions.†—Dr. H. Theél gives an account of the Holothurians dredged in the Gulf of Mexico, in the Caribbean Sea, and along the eastern coasts of the United States; the author wishes it to be regarded as an appendix to his recently issued 'Challenger' report; he describes several new species, but no new genera, and makes no general remarks.

Development of Generative Apparatus of Echinids.‡—M. H. Prouho reports that young individuals of *Strongylocentrotus lividus*, measuring 1 to 1·5 mm., have no genital pores or apparatus; the madreporic plate is pierced by two or three aquiferous pores and the sand-canal is well developed. Along this canal and supported by the same mesenteric layer there is an elongated cellular mass, which is the rudiment of the ovoid gland. In individuals of 3 mm. diameter, the genital plates are still imperforate, but the genital apparatus has begun to be formed. Delicate sections made parallel to the axis of the test reveal the existence, near the apical extremity of the growing ovoid gland, of a bud limited by a very distinct membrane. This bud, which will give rise to the whole genital apparatus, contains large nuclei. As the young urchin grows the bud developes, advances under the madreporite, and then prolonging itself under the other genital plates, makes the tour of the periproct. Opposite each interradius the ring thus formed gives off a prolongation in which the large nuclei, characteristic of the primitive bud, are always found. This is the condition of things in examples 6 mm. in size, and the genital apparatus may now be said to consist of five interradial buds connected with one another, and with the mesentery which supports the ovoid gland by a membranous circumanal ring. In individuals a little older, the five buds may be seen to give off small lateral ramifications, while their aboral end approaches and soon perforates the proper genital plate.

If this bud is given off from the ovoid gland the development of the genital apparatus of Echinids is effected by a process analogous to that described by Prof. Perrier in the Comatulidæ; it might be said that the growing gland is, or contains, a genital stolon like the dorsal organ of young Comatulids; but the author does not take this view. It is true that the

* Johns-Hopkins Univ. Circulars, vi. (1886) pp. 44–5.
† Bull. Mus. Comp. Zool. Cambridge, xiii. (1886) pp. 1–22 (1 pl.).
‡ Comptes Rendus, civ. (1887) pp. 83–5.

genital bud of the young urchin is enveloped by a membrane which is continuous with that which envelopes the ovoid organ, but it seems to be always separated from it—it can only be said that the primitive genital bud appears as a simple dependent of the mesenteric plate which surrounds the ovoid gland and the aquiferous tube.

Distribution of Sea-Urchins.*—Dr. W. Haacke communicates some interesting notes on the habits and distribution of sea-urchins considered in relation to their past history.

(1) In the first place he notes the characteristics and occurrence of two litoral Australian species, *Amblypneustes ovum* and *A. formosum*, which occur among the sea-grass and tangle banks. The former is found exclusively among the sea-grass; its colour corresponds to the greenish-yellow light of such a habitat, and its form is well adapted to its habit of climbing up and down on the sea-weed.

(2) Haacke emphasizes the necessity of caution and criticism in regard to what is often said in regard to the persistence of fossil forms in the great depths. The phylogenetically older regular sea-urchins are better represented, as Neumayr has shown, near the coast than in the deep sea. Uniformity of external conditions does not necessarily imply an unchanged persistence of ancestral environment, admitting of the persistence of primitive forms.

(3) Deep-sea fossils of previous epochs are unknown to us, and deep-sea forms must be compared with deep-sea forms. The preservation of litoral forms is very scanty, the conditions were not favourable, and the dead sea-urchins buoyed up by the gases of putrescence would then, as now, float away, and be broken up on the shore. The fossil remains both of the litoral and the upper continental areas are so scanty that a comparison of living and extinct forms becomes very hazardous. In the lower continental zone the preservation of fossil remains is more complete, and the recent extension of our knowledge of living forms has naturally led to the discovery of "living fossils." "The partial persistence of external conditions characteristic of earlier epochs has indeed favoured the survival of ancient forms, and such a persistence is not to be found exclusively in the deepest depths of the ocean, but for terrestrial animals on land, for fresh-water animals in their medium, for litoral animals near the shore, for 'continental' animals in their own zone, and only for true deep-sea forms in the abyssal region. A consideration of variations in habitat, mode of life, and forms must be associated with phylogenetic investigation. When this is done there will be no more marvel that the exploration of the deep sea has not revealed more 'living fossils.' It is younger than the shallow water, and in virtue of its peculiarity has allowed many of the old forms (which wandered into it from the latter) to die out, while others it has greatly modified."

Formation of Genital Organs and Appendages of the Ovoid Gland in Asterids.†—M. L. Cuénot thinks that it is impossible to interpret the vascular system of Asterids without having recourse to the development of the genital organs. In a young star-fish in which the gonad has not begun to be formed there is on the aboral and internal surface of the test a dorsal blood-vascular ring, which, at each interradius, gives off two cæcal vessels which are directed towards the extremity of the arm. In one interradius this ring communicates with the large sinus which incloses the ovoid gland and the sand-canal. At this time the gland is ovoid, but a little later it is prolonged into two buds which go to the right and left; these extend

* Biol. Centralbl., vi. (1887) pp. 641–7.
† Comptes Rendus, civ. (1887) pp. 88–90.

round the aboral circle, and in each interradius give off two branches which pass to the interior of the cæcal vessels belonging to two contiguous arms. Within the aboral circle and its genital vessels there is therefore a central cellular cord; this swells at the end of the vessel and becomes considerably developed, forming the genital organ which is completely surrounded by a sinus; the cells of the cord give rise to ova or spermatoblasts. An invagination of the integument now comes to meet the genital organ, which it finally puts into communication with the exterior.

This cord is directly derived from, and has the same structure as the ovoid gland; the ovum is morphologically the homologue of the blood-corpuscles, and the ovarian cells which do not become ova altogether resemble blood-corpuscles; a similar development does not take place in the testis.

The ovoid gland gives rise to yet another structure which appears before the genital organs; this is a glandular process which perforates the interradial sinus near its aboral extremity, and extends freely into the general cavity. *Luidia ciliaris* has one, *Asterias rubens* and others two, and *A. glacialis* three; they are totally wanting in *Cribrella* and *Echinaster;* Hoffmann and Ludwig have regarded them as intestinal vascular plexuses, and Jourdain as an excretory gland, but the author looks on them as belonging to the same group of lymphatic glands as the bodies of Tiedemann and the Polian vesicles.

Twelve-armed Comatula.*—Mr. A. Dendy gives a description of a female specimen of *Antedon rosacea*, in which one of the arms of each side bifurcates, giving twelve arms; with the mouth as anterior and anus as posterior, the third right arm and the fourth left arm are the abnormal ones. The second brachial of each of these resembles in shape the third radial plate, and carries on each side a third brachial, which is the starting-point for the new arm. Each of the two third brachials has a syzygy upon it. The two extra arms are supplied with ambulacral grooves, and the author suggests that it is due to these extra means of obtaining food that the specimen is of such a large size.

Morphology of Antedon rosacea.†—Dr. P. H. Carpenter calls attention to that portion of MM. Vogt and Yung's 'Traité d'Anatomie pratique' which deals with *Antedon rosacea;* he points out a number of errors of omission and commission which might have been saved by an acquaintance with what has already been published on the subject by writers other than Prof. Perrier.

Supposed Symbiotic Algæ in Antedon rosacea.‡—Dr. P. H. Carpenter criticizes the theory of Messrs. Vogt and Yung that the sacculi of *Antedon* are zooxanthellæ, and urges arguments against this view; attention is also drawn to the errors made by Perrier in the introduction to his new memoir on *Antedon.*

Cœlenterata.

Function of Nettle-cells.§—Dr. R. von Lendenfeld suggests that there can be but one explanation of the mode of action of, at any rate, the larger kind of nettle-cells or cnidoblasts; its structureless peduncle is a support, and may contract so as, under certain circumstances, to withdraw the cnidoblast from the surface; control over their movements is probably effected by

* Proc. R. Phys. Soc. Edin., cxv. (1885–6) pp. 180–3 (1 pl.).
† Ann. and Mag. Nat. Hist., xix. (1887) pp. 19–41.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 379–91 (1 fig.).
§ Ibid., pp. 393–9 (1 fig.).

means of the subepithelial nervous layer; the granular peduncle is a nerve-fibre connecting the protoplasmic mantle of the nettle-cell with the nervous system, and by means of this the movements of the protoplasmic mantle can be controlled. The explosion of the cnidoblast is caused by the contraction of the plasmatic coat which surrounds the capsule, and which in *Physalia*, as Chun has shown, is partially converted into a network of muscular fibres. This plasmatic contractile coat is excited to action by the cnidocil, for if anything touches the cnidocil the plasmatic mantle contracts, and the tube is shot forth. But the explosion is under the will of the animal, and can be prevented by means of the nerve-fibre connecting the cnidoblast with the ganglion-cells below. The apparently homologous cells of the Ctenophora do not explode, but appear to be subject to the will of the animal, as is the cnidoblast.

Genera of Plumularidæ.*—Mr. W. M. Bale adds to his revision of the genera of Plumularidæ some observations on various Australian Hydroids. With regard to Prof. Allman's division into the Eleutheroplea and the Statoplea it is pointed out that, while there is no simple distinguishing characteristic which can be said to be invariable, it is generally easy to refer a species to its proper subfamily by its general habit, and by the predominance of the characters of one group over those of the other.

Differences in the mode of branching of the hydrocaulus are to be seen between the monosiphonic species, and those in which there is a compound stem, the stem and branches being simple jointed tubes in the former, while in the latter there are supplemental tubes which are obviously hydrorhizal elements.

Among the forms described or noted, *Sertularella johnstoni* and *Plumularia watsii* are new; the memoir concludes with some critical notes on recent papers by Allman, von Lendenfeld, Ehrenbaum, and Quelch.

Medusæ of the Gulf-Stream.†—Mr. J. W. Fewkes gives an account of the Medusæ collected in the Gulf-Stream by the 'Albatross' in 1883–4; discussing the embryonal relations of the Medusæ, he refers to the important discovery on the surface of a new species (*Aeolis Bairdii*) which belongs to a genus regarded by Prof. Häckel as one of the special deep-sea forms. *Nausithoopsis* is a new genus, distinguished from *Nausithoe* by the arrangement of its tentacles and the number of marginal lappets; *Eglyroides* g. n. is distinguished by having 16–32 or more radial clubs alternating with the same number of pendulent marginal lappets; *Pausophyra*, with a general likeness to *Rhizophysa*, has two longitudinal wings on the polypites; for *Angelopsis* g. n. a new family of Angelidæ is necessary.

Parasitic Cumidæ of Beaufort.‡—Several larvæ of the group of *Cumidæ* parasitic in the Geryonidæ were found by Mr. H. V. Wilson in the gastric cavity of *Liriope*.

The earliest stage noticed was a simple two-layered sac with a single mouth-opening. The next stage was similar, but had three mouths; and two tentacular protuberances by which it was attached. In the following stage a medusa bud was developed at the point of each mouth. In several points these stages differ from those described by Metschnikoff: e. g. no special part of the sac served as a suctor, but buds sprouted out all over the surface.

For the first time, *Cumidæ* parasitic on other *Cumidæ* are recorded from the American waters. They lie free in the stomach, are transparent, and

* Trans. and Proc. Roy. Soc. Victoria, xvi. (1880) 36 pp.
† Rep. Comm. U.S. Fish Commission, xii. (1886) pp. 957–77 (24 plts.).
‡ Johns Hopkins Univ. Circulars, v. (1886) p. 47.

have twelve to fifteen tentacles; they were found in eight tentacled forms, apparently *Cunoctantha octonaria*.

Addendum to the Australian Hydromedusæ.*—A fourth addendum is added by Dr. R. von Lendenfeld to his monograph;† besides the two species of *Hydra* already described by him, viz. *H. viridis* L. and *H. oligactis* Pallas, a third and new one is formed, for a species which invariably has six equal tentacles. *H. hexactinella* is perfectly cylindrical; colourless, except that the endoderm has a slightly yellow tinge. Two kinds of cnidoblasts with different cnido-cells are found on the tentacles. The author doubts the ganglionic nature of the cells described by Jickeli as such, as he finds no nucleus in them. These cells are interposed between the ectoderm and supporting lamella, and cause a protuberance of the former. These are deeply stained, and it is "not quite impossible" that they may be the nuclei of sensitive cells similar to the palpocils of Sarsia-polyps.

New Actinozoa.‡—Dr. W. Koch has described some new forms among the Actinozoa collected by Prof. Greeff on three islands of the Gulf of Guinea. One new Alcyonarian, three Gorgonias, one Antipathes, five sea-anemones, and four Madrepores. The histology of *Zoanthus* and *Palythoa* is also discussed.

Reef-corals of the 'Challenger.'§—Owing to the great interest which was found to attach to the corals collected in shallow water by the 'Challenger,' it was arranged that Mr. J. J. Quelch should write a short report on them; owing to the necessary limitations the greater part of this memoir deals with the description of genera and species; there were 293 species belonging to 69 genera; 73 of the species are new and eight of the genera. In addition to the descriptions, there is an important analysis of the geographical distribution, and there are valuable hints as to the analysis of the influence of local conditions (e. g. temperature, sunshine, composition of water, depth of growth) on the characters of the species.

Porifera.

Hindia.‖—Dr. G. J. Hinde, in a paper on the genus *Hindia*, opposes some of the statements of Prof. P. M. Duncan, urges that the sponge occurs under various mineral conditions, and especially throws doubt on the characters of the fossil alga *Palæachlya perforans*, which Dr. Duncan has been able to detect in a large number of various fossil forms.

Isoraphinia texta and Scytalia pertusa.¶—Herr C. Lahálka reports the discovery of the remains of these two marine sponges in the Turonian strata to the south of the heights of Rohatetz, near Raudnitz, in Bohemia, which appear to be in an excellent state of preservation. The author agrees with Zittel as to the generic position of the second form.

Protozoa.

Multiplication of Amœbæ.**—Mrs. (or Miss) Lillie E. Holman records that on the 4th July, 1886, she was examining the forms of life contained in a Holman life-slide, which had been filled for several hours. It con-

* Proc. Linn. Soc. N.S.Wales, x. (1886) pp. 679–81 (1 pl.).
† See this Journal, 1885, p. 252.
‡ 'Neue Anthozoen,' &c., 8vo, Marburg, 1886, 36 pp., 5 pls.
§ Report of the Voyage of H.M.S. 'Challenger,' Monograph, xlvi. (4to, London, 1886), 203 pp. and 12 pls.
‖ Ann. and Mag. Nat. Hist., xix. (1887) pp. 67–79.
¶ SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 647–52 (2 pls.).
** Proc. Acad. Nat. Sci. Philad., 1886, pp. 346–8.

tained different Infusoria, and, among other animals, specimens of *Æolosoma*. But it seemed for some time as if there were no *Amœbæ* in the slide, until a small one was discovered near the channel. In shape it seemed like an elongated triangle, and was rather torpid, or at least moved but little. The rest of the paper we transcribe in full.

"While I was examining it, it moved up closer to the line of the channel, and another *Amœba*, about twice the size of the first one, came gliding on the scene. It moved up very close to the other, and in a few minutes I noticed that it looked as if it were trying to swallow the smaller *Amœba*, and in the same manner that it does its ordinary prey. As I had watched many *Amœbæ* and had never seen anything like this, and as I knew they did not prey on each other, and the question of their conjugation was a very doubtful one, I dismissed the idea of the larger absorbing the smaller, and concluded it was merely the fact that they were in too tight a place to allow of their passing each other, which gave them this appearance. I watched them constantly for about half an hour, in course of which time I became convinced that somethfng unusual was going on.

The larger *Amœba* had entirely surrounded the smaller one, which, however, did not lose its vitality. First it seemed to be under the endosarc of the larger, and then above it. Sometimes it would project a pseudopod out from beyond the ectosarc of the larger animal. All the time it was distinctly visible in its own individuality, if one may so call it, and did not at all seem to be trying to escape. I called Mr. Holman's attention to the singularity of the behaviour, and expressed my belief that it was a case of either cannibalism or conjugation. He expressed his disbelief in either of these cases, and observing that the water in the slide was evaporating, we allowed a little to creep in under the closed edge of the cover-glass. This seemed to relieve the large *Amœba* from the constrained position and flat contour which it had assumed, and it immediately commenced to put out pseudopods and move away; and the smaller one moved off with it, evidently engulfed in the larger one, and quiescent in that position.

The small *Amœba* occupied a position in the upper part of the larger one. As this last moved on, it seemed to push the small one in an opposite direction from that which its granules were taking, till it reached about the centre of its body. Then it commenced an evident effort to expel the smaller one. It reached out its pseudopods in every direction, gradually expelling the smaller one until it was completely discharged. The smaller one by this time assumed an almost spherical shape.

At last the large *Amœba* ceased moving, and commenced to expel refuse matter such as is common with them. It had anchored itself near some other refuse matter, probably vegetable, and really looked as if it was using it as a sort of grapple for the purpose of ridding itself of the rejected smaller *Amœba*. It was successful; for in a few moments it moved away to the upper part of the field, leaving the round ball, looking in every respect like an encysted *Amœba*, near the little group of refuse. It went on in the field, and we followed it for some time, when it became quiet, and we went back to the encysted one. I watched it to see what would happen next, for it seemed as if there must be some strange sequel to our remarkable observation, and the watching was not in vain. The flat disc commenced by a sort of contractile movement to throw out particles or granules, as if it were laying eggs. I can think of no other expression, although the particles, while approximate in size, had not regularity of shape. This continued till the *Amœba* again assumed its clear and transparent appearance, and at last, seeming to fully regain its activity, put out a pseudopod and moved in the field, leaving behind it a group of particles or granules.

Only for a little while, however, did it move; in a few moments it lost its animation, seemed to become transparent, and at last faded into one of those discs which seem to be merely the shells of once active forms. I did not see it move again.

This observation was carried on continuously during two hours and a half, and every stage watched most closely. I was at a loss what to call it, if not a clear case of conjugation and separation.

The most convincing proof to my mind that this was a proceeding which was for a purpose, was given when, two nights after, this slide, which was laid carefully aside for future examination, was found to be full of young *Amœbæ*. They literally swarmed; I counted in the field at one time twenty-four of uniform size, while I have no hesitation in saying that there were between one and two hundred in the slide, which had before held but two. The worn-out disc was recognized, and also what seemed to be the remains of the larger *Amœba*."

Digestive Process in some Rhizopods.*—After a brief summary of the observations of previous writers, Miss M. Greenwood describes her own results, which were derived from experiments on *Actinosphærium* and on *Amœba*.

The act of ingestion.—In *Amœba proteus*, in which there is a more or less definite posterior extremity, it is this region that ingests most actively. The food is enclosed by the flowing out of two pseudopodia, which gradually close behind the prey. In the case of quiescent solid matter, very little fluid is included, but when the prey is active, more or less fluid is involved in a vacuole; but the amount depends on the activity of the prey to some extent. Ingestion was never observed in the anterior, moving region of the *Amœba*.

In *Actinosphærium*, the prey can be taken in anywhere; being captured by two pseudopodia, and enveloped in a film of hyaline protoplasm which advances from the side; very little water is included. The time taken in the process varies; sometimes the prey will swim away, after being in contact with the captor for an hour.

Changes undergone by ingested bodies.—The substances ingested are divided into four groups: (1) Starch, &c.; (2) Fat-globules; (3) Proteids (*a*) enclosed in a resisting wall or (*b*) "unshielded"; and (4) useless material, e. g. litmus. In *Amœba* the starch was extruded, after some hours or days, unaltered. Fat was likewise unaltered. Protococcus and Torulæ were observed as examples of protected proteids; the torulæ were unaltered, except for the loss of vacuoles; but in the case of chlorophyll-containing bodies, their green colour was changed to brown, after a day or two, indicative of some action on the proteid. Of "unshielded" proteids, *Monas Dallingeri* was noticed; the protoplasm became "turbid" after seven minutes; the flagellum broke down after fifteen minutes. The ingestive vacuole becomes digestive; but after the first changes on the food, it gradually disappears, and the resulting granules distributed about the *Amœba*. In the case of *Algæ*, though the change from green to brown indicates a change in the protoplasm, the cell-wall is not perforated; this therefore precludes the idea of "direct protoplasmic action," and indicates that the fluid in the vacuole diffuses through the cell-wall. Probably fresh fluid passes into the vacuole, and this then forms a vacuole of ejection; the act of ejection takes place with some force. But in the case of "unshielded protoplasm" no vacuole of ejection is formed. In *Actinosphærium* the starch grain was unaltered; the fat-globules appear to be acted on in some way,

* Journ. of Physiol., vii. (1886) pp. 253–73.

as the protoplasm round them becomes very granular, and a vacuole appears *gradually* after ingestion. The action on shielded proteid was the same as in the case of *Amœba*. As an example of "unshielded proteid," the digestion of a small Crustacean larva was observed; after eight hours its shape had been lost, and a vacuole had appeared. An Euglenoid form continued to struggle for 2½ hours, but after 15 hours was disintegrated, though green colour remained. All ejecta are passed out by means of a vacuole. There is probably some difference in the process of digestion in *Amœba* and *Actinosphærium*.

The means by which the digestive changes are brought about.—Direct contact with the protoplasm is not necessary, so that the "secretion of some digestive fluid" must take place in the vacuole in *Amœba*. Innutritious material does not act as stimulus to the secretion; and ejection is in this case unaccompanied by any "viscid fluid." As to the nature of the digestive fluid, no very definite result is arrived at. Blue litmus remained unchanged for several hours. Methyl-violet and tropæolin were unsuccessful. But probably the secretion is *not acid*.

The paper concludes with a tabular statement of the changes observed continuously during the action of ingestion and digestion: (A) in *Actinosphærium* for ten hours; and (B) in *Amœba* for nine days.

Multiplication of Leucophrys patula.*—M. E. Maupas states that *Leucophrys patula* grows very rapidly, owing to its powerful buccal apparatus enabling it to be a voracious and successful carnivore. Its growth and its power of fission are in relation to this power of absorption—individuals isolated and placed in a rich medium divide four or five times a day, that is to say, one individual gives rise in twenty-four hours to thirty-two descendants. When, owing to its abundant multiplication, it has used up the great quantities of food at its disposal, this infusorian undergoes a series of remarkable and unique changes.

The individuals fix themselves to the edges of the drop of water in which they are living, and roll themselves up into a ball, as if they were going to encyst, but they form no cyst; the buccal apparatus disappears entirely, and the mouth is merely indicated by a shallow groove, which is difficult to detect; they then begin to undergo transverse division, but do not move nor eat afterwards; the divisions succeed one another rapidly, so that in a few hours each *Leucophrys* gives rise to sixty-four individuals. These take on an oblong cylindrical form and begin to move about; they are only 50 μ long and 19 to 20 μ broad, while their parents were 150 μ long and 100 μ wide. Had not their direct descent been observed it would be impossible to believe that they were derived from their parents, so different are they in all their characters.

For several days they exhibit great mobility, and are for the most part eaten up by the contemporaries of their parents who have not undergone division; later these latter do so. The products of division which have escaped being eaten by their relatives again become immobile, and during this period of rest they take on the typical form of the *Leucophrys* and re-form their buccal apparatus; when food is given them they absorb it at once, and rapidly grow up to the normal size of the species. No process of conjugation was, it is to be noted, observed at any stage. It would seem as if we had here to do with a species which preserves itself by autophagy. The observations of Claparède, Stein, and Balbiani on the dwarf forms of *Stentor cæruleus* may perhaps receive their explanation from the account here given.

* Comptes Rendus, ciii. (1886) pp. 1270–3.

Multiplication of Leucophrys patula.*—Prof. E. G. Balbiani, referring to the paper by M. Maupas, points out that *Leucophrys* affords only an example of facts already known; the formation or non-formation of a cyst adds nothing essential to the phenomena—thirty-three years ago Stein observed a similar mode of reproduction in *Colpoda cucullus*, and, in addition to other naturalists, M. Balbiani and his assistants have made similar observations. The latest form studied is now proposed to be called *Trichorhynchus tuamotuensis* g. et sp. n., found by M. Bouchon-Brandely near the Tuamotu Islands. These forms, after a few days' movement, become stationary and secrete a delicate cyst, in which they divide into two and sometimes into four new individuals, which emerge from the cyst on its breaking into two almost equal parts. This mode of multiplication goes on as long as there is nourishment in the fluid; when it fails the remainder encyst, and remain encysted, either entire, or dividing into two or four segments. The new genus is characterized by a tuft of long, stiff, diverging cilia which surround a conical protuberance which forms a kind of projecting lip above the mouth; the body is cylindrical, 0·04 mm. long and 0·028 mm. wide.

Zoothamnium arbuscula.†—Mr. J. Spencer describes the separation of the reproductive zooids from the colony. Around the base of a spheroidal zooid, near its attachment to the stem of the colony, a thread of protoplasm makes its appearance; this becomes an undulating ribbon, which then breaks up into a ring of cilia. Meanwhile the sphere has become biconical, and the ring of cilia gradually becomes equatorial and even nearer the opposite pole than to that where it started. This body now swims away. Its further fate was not followed. The ordinary zooids gradually disappeared from the colony during the above changes.

New Choano-flagellata.‡—Dr. A. C. Stokes describes three new species of these Infusoria.

Monosiga limnobia is especially noticeable in the equatorial position of the contractile vacuoles. This species seems able to live either in standing or in fresh waters.

Salpingœca eurystoma is characterized by the very wide mouth and everted edge of the lorica; to the bottom of which the animal is sometimes attached by a thread.

Desmarella irregularis forms colonies of fifty or more: the individuals being connected sometimes by a delicate thread of protoplasm, sometimes by being directly united laterally. This species is peculiar amongst the whole group of Choanoflagellata, in that the food is ingested at the *external* base of the collar: moreover the currents on the collar are reversed, being downwards, externally, and upwards, internally.

New Parasitic Infusorian.§—Herr Lindner reports the frequent occurrence, in the Kassel district, of a peritrichous Infusorian with parasitic habit. It occurs in foul water, in sewage, in the fæces and even in the urine of typhus patients, &c. Prof. Bütschli referred the form to the free-swimming stalkless *Vorticellæ*. Its general structure is Vorticella-like. Resting capsules are formed in unfavourable environment, and many forms are found closely united by a glue-like substance. Longitudinal division and conjugation were observed. The parasite feeds on fluid albuminoid

* Comptes Rendus, civ. (1887) pp. 80–3.

† Journ. Quek. Micr. Club, iii. (1886) pp. 5–7 (1 pl.).

‡ Amer. Mon. Micr. Journ., vii. (1886) pp. 227–8 (3 figs.).

§ Ber. 59 Versammlg. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1887) pp. 733–4.

material, and on *Bacteria*, both indifferent and virulent. It can thrive in the most varied media when albumen is present and free acid absent. The author describes the form as "ascoid."

Adelosina.*—M. C. Schlumberger is of opinion that to insure a successful study of the Miliolidæ it is indispensable to make delicate sections passing through the initial chamber. Starting, for a type, with *Adelosina bicornis*, which is very common in the Mediterranean, he calls it form A, and then he compares with it another kind which he calls form B; considering these species and comparing them with three species of *Biloculina*, he finds that form A presents a special character common to all the individuals of each of these groups. In *Adelosina* it is a megasphere completely enveloped by the first chamber, which becomes lenticular; in *Biloculina* it is a megasphere with two series of chambers in two planes of symmetry; in *Triloculina* and *Quinqueloculina* the megasphere is surrounded with three or five series of chambers. In form B of all the four genera the microsphere is always surrounded by a cycle of five chambers. The author concludes that in the classification of the Miliolidæ the form A determines the genus, and form B the species. In *Spiroloculina*, however, it is to be noted that there may be an initial polymorphism in form A.

New Form of Sarcodina.†—Dr. R. Moniez describes a new and unique parasite, found in the visceral cavity of several species of Ostracoda and Cladocera, but especially in *Cypris salina*. A number of the extraordinarily variable individuals are described and figured, and the general characteristics, such as they are, are summed up as follows;—body flattened, of variable size and form, consisting of absolutely homogeneous protoplasm; reproduction by fissures which may appear at any point of the individual mother, and constrict off a mass of protoplasm which forms a new individual. The unique and enigmatical species is named *Schizogenes parasiticus*. Were it not a parasite, the author would place it without hesitation among the Monera, but making allowance for the probable degeneration, is inclined provisionally to rank it with the Rhizopoda as a new family of Sarcodina.

New Type of Sporozoa.‡—Dr. R. Moniez gives an account of *Gymnospora*, a new type of Sporozoa, which he found in a larva of *Vanessa urticæ*, and which appears to be one of the Coccidia; its spores differ from those of *Klossia* in having no thick investing membrane; as the test is black, the species may be called *G. nigra*.

BOTANY.

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

a. Anatomy.§

(1) Cell-structure and Protoplasm.

Growth of Plasmolysed Cells.‖—According to Herr G. Klebs, cells of *Zygnema* and *Œdogonium*, which have been plasmolysed in 10 per cent. glucose, retain their life for a long time in this condition, and exhibit phenomena of growth. The strongly contracted protoplasts of *Zygnema*

* Bull. Soc. Zool. France, xi. (1886) pp. 544–57 (1 pl.).

† Journ. Anat. et Physiol., xxii. (1886) pp. 515–23 (1 pl.).

‡ Bull. Soc. Zool. France, xi. (1886) pp. 587–94.

§ This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

‖ SB. Versamml. Deutsch. Naturf. u. Aerzte, Sept. 22, 1886. See Bot. Centralbl., xxviii. (1886) p. 156.

surround themselves with new strongly laminated cell-walls, grow greatly in length, take up the most various and abnormal forms, and divide in the ordinary way. The *Œdogonium*-cells form in this solution also new laminated membranes, scarcely increase in length, and divide, not in the ordinary way, but in that of *Cladophora*. These phenomena take place only in cane-sugar, grape-sugar, milk-sugar, and mannite, light being necessary to them. If *Zygnema* is placed in 10 per cent. glucose in the dark, it does not grow in length, and forms no new cell-walls; but the protoplasts remain alive for some weeks, till they gradually die of want of nutriment.

When elongated *Zygnema*-cells are plasmolysed, the protoplast breaks into two halves, one of which contains the single nucleus, the other having none. Only the portions of the cells which contain the nucleus form membranes, grow in length, and regenerate the entire cells; the parts which contain no nucleus have not the power of forming a cell-wall or of growing in length, but they may retain their life for a long while, increase in volume, and form starch.

Separation of Silver by active Albumin.*—Dr. T. Bokorny, referring to the observations of Loew and himself,† that living protoplasm blackens in a very dilute alkaline silver solution while dead protoplasm does not, replies to the explanation offered by Hoppe-Seyler that this is due to the presence in living organs of hydrogen peroxide (H_2O_2). If the least trace (1 part in 100,000) of H_2O_2 were present in the living cell, sufficient iodine would be set free from potassium iodide with a very dilute solution of iron sulphate to produce a sensible reaction with starch. Bokorny found, however, that this was not the case with *Spirogyra*-cells containing abundance of starch-grains, while the starch-grains imbedded in the protoplasm at once became blue if treated with a solution of H_2O_2 in the presence of the same reagents. In living *Spirogyra*-cells saturated with H_2O_2, and laid in a very dilute silver solution, the protoplasm rapidly blackened, while the cell-walls and cell-sap remained perfectly colourless, while dead *Spirogyra*-cells showed no reduction of silver whatever. The author concludes that the reducing property depends on the presence in living cells of a body (active albumin), which passes over on the death of the cell into a body not possessing this property. He found that the effect of H_2O_2 on this property of active albumin was at first to increase its activity, this being subsequently followed by its complete suppression.

(2) Other Cell-contents.

Crystalloids in the Cell-nucleus.‡—Crystalloids as a constant inclosure in the nucleus have hitherto been known only in *Lathræa squamaria*, *Utricularia*, and *Pinguicula*. According to Dr. H. Leitgeb, they occur also in *Galtonia* (*Hyacinthus*) *candicans*, especially in the epidermal cells of the perianth-leaves and stamens, but also in the cells of the mesophyll, in the epidermis of the flower-stalk, in the wall of the ovary, and occasionally in other organs and tissues of the plant, but always much smaller and less fully developed; it is only in the underground parts that they are not found. They have the form of prismatic rods, are seldom solitary, but usually in groups. They exhibit protein reactions, and may probably be regarded as reserve-substances. In *Pinguicula* they are, under certain circumstances, used up in the new formation of organs. In the perianth leaves of *Galtonia*, they are absorbed some time before the death of the

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 347–58.
† See this Journal, 1884, p. 249. ‡ MT. Bot. Inst. Graz, i. (1886) pp. 113–22.

cell, but their substance is probably used up in the processes which subsequently go on in the cell, for the absorption of the crystals takes place even in unfertilized blossoms. The absorption may be effected in various ways.

The formation of crystalloids appears to have a certain relationship to the production of flowers and fruit. In *Lathræa* they are found only in the flower-bearing stems; in *Pinguicula* they remain until the appearance of the blossoms. In contrast to other albuminous substances, crystalloids in the nucleus are either confined to the superficial cells, or are most abundant in them. In *Urtica* and *Campanula* they are found only in the trichomes.

Chromoleucites.*—The chromoleucites of flowers and fruits are stated by M. L. Courchet to be formed either from a stroma of proteinaceous character, which is generally colourless, or from pigment-granules of a certain degree of fluidity and of variable size scattered more or less regularly in the stroma. He enumerates five distinct types of pigment, viz.: (1) True crystals formed from the pigment alone without any admixture of protoplasm (root of carrot, fruit of tomato, melon, and cucumber). (2) Rounded, or of an irregular contour, with a homogeneous appearance, owing to the minuteness of the pigment-grains (berry of asparagus. (3) Spindle-shaped, or of the form of a plate with many points (fruit of honeysuckle). (4) The coloration is due to a coloured sap (ovary of *Salpiglossis*). (5) The colour is due neither to chromoleucites nor to a coloured sap, but to an orange-yellow coloration of the walls of the external cells (fruit of several species of *Solanum*).

Colouring Matter of Aceras anthropophora.†—Sig. P. Severino has studied the nature of the colouring matter in the flowers of the variety *purpurea* of the man-orchis. He finds it to be due to a solid granular substance which is probably a modification of chlorophyll.

Nägeli's Starch-cellulose.‡—Herr A. Meyer disputes the theory of the structure of starch-grains first put forward by Nägeli, and since generally adopted, that they consist of an intimate admixture of two distinct substances, true starch (granulose), and cellulose (farinose). The action on starch-grains of either saliva or concentrated sulphuric acid entirely removes the granulose, leaving behind a skeleton composed of a substance which has been termed amylodextrin.

According to Meyer, amylodextrin always results when starch-grains are treated with dilute acids, diastase, pepsin, or saliva, this being the first result of hydration at a low temperature, afterwards passing over into dextrin and soluble sugar, the skeleton also then entirely disappearing. It is difficult to obtain amylodextrin entirely free from dextrin and sugar; and this would be impossible were it not that it has a tendency to aggregate into sphero-crystals very similar to those of inulin; these sphero-crystals are occasionally disc-shaped, more often spherical, often laminated, and closely resemble centric starch-grains, even in their appearance under polarized light. Micro-chemical examination shows almost conclusively that the skeletons obtained by the action of acids and of saliva on starch-grains and amylodextrin, are identical substances. Amylodextrin and "starch-cellulose" are, therefore, not present in the intact starch-grain, but are products of the action upon it of hydrating agents, and there is only one substance present in normal starch-grains, which the author proposes to call "starch-substance."

* Bull. Soc. Bot. France, viii. (1886) pp. 178–81.
† Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 315–9.
‡ Bot. Ztg., xliv. (1886) pp. 697–703, 713–9.

There are, however, starch-grains which contain amylodextrin and dextrin, in addition to starch-substance; but they are readily distinguished from normal starch by being coloured red-violet or an intense red with iodine. The different behaviour of the different layers of starch-grains Meyer believes to depend on their different degrees of porosity, the substance of all the layers being destitute of water, and alike physically and chemically.

Presence of Glyoxylic Acid in Plants.*—MM. H. Brunner and E. Chuard consider glyoxylic acid to be formed by a process of reduction.

In the first place oxalic acid is produced by the reducing action of hydrogen on carbonic acid.

$$2H_2CO_3 + H_2 = 2H_2O + C_2H_2O_4.$$

Oxalic acid is then reduced in a similar manner to glyoxylic.

$$C_2H_2O_4 + H_2 = H_2O + C_2H_2O_3.$$

Erlenmeyer considers that the hydrogen in the above equation is obtained from water, which, under the action of light and chlorophyll, breaks up into hydrogen and hydrogen peroxide. Glyoxylic acid, on reduction, produces glycolic, tartaric, malic, and succinic acids.

The authors used various materials for the extraction of glyoxylic acid unripe grapes were first tried, but the quantity found was small. Better results were obtained with unripe pears and apples, and with the fruits and leaves of *Ribes Grossularia* and *R. nigrum.*

Glyoxylic acid may be considered as the first member of the series which contains formic, glycolic, and oxalic acids, and it is especially found in very young fruits at an early stage of their development. The other acids make their appearance and increase little by little as the fruit developes, while the first-named members decrease in quantity or even disappear at the moment of maturity. This is especially the case with glyoxylic acid.

Micro-chemistry of the Epidermal Tissue.†—M. J. Dufour describes a number of substances found in the epidermal tissue of plants, the study of which is specially interesting as throwing light on some of the physiological functions of that tissue. The substances he classifies under various heads.

(1) *Tannins.*—Tannin is widely distributed in the epidermal tissue; it occurs more frequently in the upper epidermis than in the lower, often presenting the appearance of drops of oil, but these are easily distinguished by their dissolving in water. Two principal forms are met with, which are distinguished by the colour given with salts of iron, one being blue and the other greenish-black. Examples of the first form are *Rhus glabra* and *Lythrum tomentosum;* of the second, *Bupleurum longifolium.* The epidermal tissue of ferns frequently contains tannin, as *Aspidium Lonchitis, A. Filix-mas, Cystopteris alpina,* &c.

On adding alcohol to an epidermal tissue, a colourless finely granular precipitate is sometimes obtained; this, the author states, is frequently due to tannin. Such a precipitate is obtained with *Lychnis Viscaria, Eranthis hyemalis,* &c., and with Leguminosæ and Umbelliferæ.

Iodide of potassium gives generally a brown or colourless precipitate with tannin; sometimes a yellow or orange colour is obtained, e. g. *Delphinium staphisagria* and *Daphne Laureola.*

* Bull. Soc. Vaud., xxii. (1886) pp. 162–9. † Ibid., pp. 134–42.

A reaction worthy of special attention is that of tannin with osmic acid. If to a solution of tannin a little hydrochloric acid and then a few drops of osmic acid (1 per cent. solution) are added, an intense blue is obtained. With osmic acid alone a black colour is usually obtained; an exception to this is *Sedum Telephium*, which gave blue.

Usually the tannin is spread uniformly through the cells, but sometimes some of the cells become as it were reservoirs of tannin, while others contain watery cell-sap. In *Sedum Telephium* numbers of these reservoirs or idioblasts are found in both the upper and lower epidermides. They are easily recognized by being much larger than the adjacent cells. Those on the lower face of the leaf contain in addition a rose-coloured pigment.

With a salt of iron the ordinary cells give a greenish-black colour, and the idioblasts a bluish-black; we have here the two forms of tannin side by side. In the genus *Primula* a number of the species contain very characteristic idioblasts.

(2) *Soluble starch.*—This substance occurs in some plants, almost exclusively in the epidermal tissue.

(3) *Sphæro-crystals of Linaria striata.*—On treating fragments of the epidermis of this plant with alcohol, the sphæro-crystals are seen adhering to the walls of the cells. They are of a yellowish colour, and their organic nature can be demonstrated by the action of heat.

(4) *Crystals of calcium oxalate* sometimes occur in the epidermal cells. They are either enclosed in special cells (*Euonymus latifolius*), or are scattered sparsely in the ordinary cells (*Cynosurus cristatus*), or occasionally a mass of small crystals in various forms is found (*Commelyna communis*).

(5) *Crystalloids and analogous bodies.*—Bodies which belong to this class are found in the epidermal cells of *Campanula thyrsoidea*. They are coloured yellow by iodine, and swell up under the action of caustic potash.

(6) *Oil.*—Occasionally in epidermal cells and stomata, e. g. *Weigelia rosea*, *Hoya carnosa*, &c. Idioblasts containing oil are found in *Asarum europæum*, *Aristolochia rotunda*, and *Asperula taurina*. Those in the upper epidermis of *Asarum europæum* are 20–35 μ in diameter, those of the lower epidermis 40–70 μ long, 30–40 μ broad. The oil is coloured brown by osmic acid, and can easily be extracted by ether or alcohol.

(7) *Chlorophyll* is often present in epidermal cells, as has been already pointed out by M. Stöhr. In *Swertia perennis*, *Cucurbita Pepo*, &c., chlorophyll granules were found inclosing starch-grains.

(8) *Pigments.*—Rose-coloured pigments exist in the epidermal cells of certain plants. In *Anagallis arvensis* the pigment is confined to special cells.

The above substances can be classified in two categories from a physiological point of view.

(1) *The assimilating substance or chlorophyll.*—Where this substance occurs in abundance, as, for example, in ferns, the epidermal tissue produces starch largely.

(2) *Substances eliminated by the plant* in the course of its chemical transformations. Among these tannin, soluble starch, calcium oxalate, and oil may be mentioned. The epidermal tissue here acts as a reservoir for the substances which are no longer of service to the plant.

(3) And finally, *water*, in those plants where the epidermis plays the part of a reservoir, and contains the water required by the leaf for the function of transpiration.*

* Cf. *infra*, p. 261.

(4) Structure of Tissues.

Molecular Structure of Vegetable Tissues.*—From an examination of the polarizing phenomena of the cells and tissues of a large number of plants belonging to Cellular Cryptogams, Vascular Cryptogams, and Phanerogams, Herr N. J. C. Müller classes them under four types as respects molecular structure. In the first two types the molecules have a globular form, with the radial axis either longer or shorter than the two tangential axes, which are equal in length. In the two other types the molecules are cylindrical, with optical axes of three different lengths, one radial, another parallel to the axis of the cylinder, the third also tangential, but at right angles to the axis of the cylinder. Of these the longitudinal axis is always either the longest or shortest, the tranverse axis being always intermediate in length between the two others. The relative position of the axes is not unfrequently disturbed by torsion.

Nuclear Sheath.†—Dr. H. de Vries traces the presence of a nuclear sheath right up to the growing apices of roots; it is this layer, and not the pericambium, which limits the pressure, as is seen from the phenomena in older roots. These two layers form together a stratum of close cells without intercellular spaces. The currents of protoplasm in the various layers of tissue are described, and especially in the nuclear sheath. The granules pass here in a broad stream along the tangential and transverse walls. There is also a constant current of protoplasm in the living cells of all the layers of tissue in the young roots, and here also especially along the tangential and transverse walls. The direction of the current is such as to serve for the transport of water from the root-hairs to the vascular bundles, and of nutrient substances from the older parts of the root to the layers of growing tissue.

Annual Formation of Cork.‡—According to Herr A. Gerber, it is not in all trees and not in all seasons that the cork forms a distinct ring every year. He distinguishes three distinct types in this respect. The yearly increase of cork varies greatly, from one row of cells in *Salix* to 100 rows in *Quercus suber*. It is usually strongest in the first year, and nearly constant after that. The number of rows in cells stands in inverse proportion to the thickness of their walls.

Pericycle.§—M. J. d'Arbaumont expresses views somewhat divergent from those of Van Tieghem ‖ as to the origin of this tissue. He regards the central cylinder as divisible into two main parts or regions, one corresponding to the primordial conjunctive tissue comprising the pith and the whole or a portion of the primary medullary rays, the other to the secondary formative tissue, from which proceed, on the one hand the xylem, on the other hand the soft bast or pericycle.

In five herbaceous plants examined, the author found the pericycle to be a product of differentiation of an unbroken zone of formative tissue, independent of the primordial meristem, from which the soft bast and xylem proceed; this zone is an integral portion of the fibrovascular bundles. In the Cucurbitaceæ we find a different structure; the pericyclical layer is divided into two parts, one internal, parenchymatous, broken up, and remaining adherent to the xylem of the bundles, the other external, fibrous,

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 1–49 (4 pls.).
† Maandbl. v. Natuurwet., xiii. (1886) pp. 53–68. See Bot. Ztg., xliv. (1886) p. 788.
‡ Zeitschr. d. Naturwiss., iv. (1886) pp. 451–88.
§ Bull. Soc. Bot. France, viii. (1886) pp. 141–51.
‖ See this Journal, 1886, p. 266.

and continuous, localized at the periphery of the central cylinder, and separated from the bundles by several layers of fundamental tissue.

Commenting on this paper, M. L. Morot * maintains that both the pericycle and the pith may be entirely parenchymatous or entirely sclerenchymatous, or partly the one and partly the other; in the last case, the sclerification may be bounded at the outer or inner border of the vascular bundles, or may form a continuous zone, or may present a more or less irregular appearance.

Development of Tracheides.† — Herr L. Kny discusses the question whether elongated fibriform tracheides are, like vascular tracheides, developed out of a single cambial cell, or from a fusion of a number of cells. In Coniferæ, and in many Dicotyledones the former is certainly the case, but in many Monocotyledones with secondary growth in thickness, e. g. *Aloë*, *Yucca aloifolia*, *Dioscorea convolvulacea*, *Dracæna Draco*, and *Aletris fragrans*, he was able to determine that they were the result of the coalescence of several superposed cambial cells. In some instances, they are from 26 to 30 times the length of an ordinary cell, and contain at first as many nuclei as that number of cells of which they are composed. The ends of such fibriform tracheides are completely closed.

Central Cylinder of Stem.‡—MM. P. Van Tieghem and H. Douliot point out that in the cases described by de Bary as concentric bundles in which the xylem is internal and the liber external, the concentric bundles really consist of several central cylinders, resulting from the ramification of a single central cylinder. The disposition of the vascular bundles in the stem may be arranged under three types, viz. (1) A single central cylinder (*monostelic* structure); this includes all roots except those of Lycopodiaceæ, the greater number of the stems of Phanerogams, the petiole of Solanaceæ, Cucurbitaceæ, &c.; (2) Several central cylinders (*polystelic* structure); including the stem of species of *Auricula* and *Gunnera*, the greater number of ferns, Marsiliaceæ, Selaginellaceæ, and Lycopodiaceæ, the petiole of many ferns, and the root of Lycopodiaceæ; (3) Vascular bundles isolated, without any central cylinder (*astelic* structure); the stem of Nymphæaceæ, of *Hydrocleis*, and of several species of *Ranunculus*; the lamina of fern-leaves.

Structure of Crassulaceæ.§—According to M. H. Douliot, the stem and roots of Crassulaceæ are normal in their primary structure; but in the stem secondary formations occur, giving the appearance of a "polystelic" structure ‖ when the concentric foliar bundles increase in size. The same may take place in the root from divisions of the generating layer in several arcs; but the modification is here again secondary, and the "polystelism" only illusory.

Anatomy of Casuarineæ.¶—M. H. Lecomte has examined the anatomical structure of several species of *Casuarina*. He agrees with the prevalent view that the longitudinal ridges on the stem are of the nature of decurrent leaves, as is shown by their possessing a palisade-parenchyma and a special fibrovascular bundle in each rib. A transverse section of a young branch presents two concentric circles of vascular bundles, the outer of which belongs to the leaves, the inner to the central cylinder of the stem, its bundles being alternate with those of the outer circle. The course of the vascular bundles presents a striking analogy to that which

* Bull. Soc. Bot. France, viii. (1886) pp. 203–6.
† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 267–76 (1 pl.).
‡ Bull. Soc. Bot. France, viii. (1886) pp. 213–6.
§ Ibid., pp. 299–306 (7 figs.).
‖ See preceding note.
¶ Bull. Soc. Bot. France, viii. (1886) pp. 311–7.

occurs in the Equisetaceæ. The bud which is formed in the axil of each tooth of the sheath which incloses the base of each internode, receives its vascular system from the lowest region of each bundle of the internode above it. Each leaf is separated from the stem by a layer of suber.

Anatomical Structure of Loranthaceæ.* — Herr G. Marktanner-Turneretscher treats of the physiology and anatomical structure of *Viscum album*. Specially worthy of notice is the fact that the assimilating tissue, in its specific form as palisade-tissue, is not formed till the second year. The ends of the fibrovascular bundles were examined, and it was found that the tracheïdes terminated generally in a club-shaped swelling. The fibrovascular bundles in the leaf had no parenchymatous sheath. The stomata were found in all possible stages of development in the mature epidermis.

The author then describes the anatomical structure of *Loranthus europæus*. Periderm is found in the stem in an early period, and this constitutes one of the differences between *Loranthus* and *Viscum*. The deciduous leaves have no typical palisade-cells, and the fibrovascular bundles have no parenchymatous sheath. Frequently, as in *Viscum*, the tracheïdes end in a club-shaped manner. The formation of the water-receptacles is characteristic on the margin of the leaf near to the apex. They consist of a spherical aggregate of conical cells, which cells, on account of the constitution of their cell-walls, are known as mucilage-cells. The author points out the relation of these mucilage-cells to the ends of the fibrovascular bundles, and in conclusion states that rhombohedric crystals of calcium oxalate are to be found in the parenchyma of the stem.

Formation of Thullæ.†—Herr J. F. A. Mellink describes a peculiar structure in the leaf-stalk of *Nymphæa alba*, consisting of large cavities opening outwards by a narrow fissure, and reaching from the epidermis to the vascular bundles. The large air-cavities in the neighbourbood of these wounds were filled with hair-like structures resembling thullæ in their mode of development, since they result from the swelling of the parenchymatous cells which bound the intercellular spaces.

Epidermis as a Reservoir of Water.‡—According to M. J. Vesque, it is very rarely that the functions of the epidermis are confined to those of protection. Even when it is reduced to a single layer of cells, it serves, in the great majority of cases, also as a reservoir of water, giving it up to the assimilating tissue when the latter is in need of it. For this purpose it is necessary that the epidermal cells should possess the power of changing their volume, and that their osmotic properties should be less than those of the cells to which they give up their water. The mode is described in the paper by which this property of the epidermis was directly proved in the case of a large number of plants. The mean quantity of water given up in this way to the assimilating tissue is 40 per cent. of their maximum volume. The general absence of chlorophyll from the epidermal cells appears to be an adaptation to promote this function; water passes with very great ease from one cell of the epidermis to another.

Aquiferous System in Calophyllum.§—M. J. Vesque gives a comparative sketch of the arrangement of the aquiferous system in the leaves of certain species of *Calophyllum*, and sees in the variations in the arrangement of this system a means of classifying the species of this genus. Between the secondary nervures of the leaf, lying below the palisade-cells,

* SB. K. Akad. Wiss. Wien, xci. (1886) pp. 430–41 (1 pl.).
† Bot. Ztg., xliv. (1886) pp. 745–53 (1 pl.).
‡ Comptes Rendus, ciii. (1886) pp. 762–5.
§ Ibid., pp. 1203–5.

are certain secreting canals which run from the median to the marginal veins. The aquiferous system is closely related to these canals. It consists of spiral tracheïdes, terminating obliquely or in a point, which are grouped in a variable number of layers, embracing the lower and lateral surfaces of the secreting canal. More rarely they are united into a bundle lying completely below the canal, as in *C. trapezifolium* and *C. Thwaitesii*, or more rarely still, around the sides and upper surface, as in *C. Pseudo-tacamahaca*. This apparatus is present in all the species. It communicates with the bundles of the secondary veins by short fascicles of straight tracheïdes, and fibres, which traverse the parenchyma. The endoderm of the bundles is continued on the connecting fascicles and on the aquiferous system. The author considers the apparatus may either be a hypertrophy of the last ramifications of the fibrovascular system, the phloem of which is extinct or represented sometimes only by some elongated parenchyma cells, or it may consist of vascular reservoirs, due to the transformation of parenchyma cells, despite the presence of endoderm.

Vesicular Vessels of the Onion.*—In investigating the vesicular organs with the object of determining whether or not the transverse walls are perforated so as to place the cavities of successive segments in communication, Dr. S. H. Vines and Mr. A. B. Rendle have observed that, in the quiescent winter condition of the bulb, there are patches of callus—easily made conspicuous by staining with corallin—on the transverse walls. From this they infer that the transverse walls are perforated, the canals through them being open in the active, and closed by callus in the quiescent condition of the bulb, just as is the case with sieve-tubes. This inference has, however, to be confirmed by an investigation of the bulb in the active condition. The authors also observe that each segment of a vesicular vessel contains a large nucleus.

(5) Structure of Organs.

Origin of Lateral Roots.†—According to MM. P. Van Tieghem and H. Douliot, while the terminal root is sometimes endogenous, as in grasses, *Canna*, *Tropæolum*, &c., the lateral roots have almost always an endogenous origin, the only exceptions being in the Cruciferæ. The secondary roots of all orders are always endogenous, while adventitious buds are usually exogenous. With regard to the mode in which endogenous roots force their way to the surface, the authors differ from previous observers. It is not by compression and reduction, or any other purely mechanical mode, but by the absorption or actual digestion of the contents of the cells of the mother organ with which they come into contact. This purely physiological process was observed by them in the case of terminal, lateral, and secondary roots of a large number of plants belonging to a great variety of natural orders. If the cells attacked contain starch, this is first of all absorbed, then the protoplasmic contents, and finally the cell-wall.

The authors dissent from the conclusion of M. Mangin,‡ that the cortex of the root originates, in Monocotyledons, from the central cylinder. As the result of a large number of observations on plants belonging to different orders of Monocotyledons, they assert that in all cases the central cylinder of the root proceeds from the pericycle of the stem, while the cortex and the root-cap have a common origin in the internal layer of the cortex of the stem.

* Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
† Bull. Soc. Bot. France, viii. (1886) pp. 252-4, 342-3.
‡ See this Journal, 1883, p. 241.

Changes in a Rooting Ivy-Leaf.*—M. E. Mer found that an ivy-leaf dipped in water by the free extremity of the petiole produced at that spot a cushion from which roots were developed. Placed then in contact with the soil, the roots increased and fixed themselves, and the root was kept alive for a period of seven years; there was no production of buds, as in *Begonia* leaves, to deprive it of its store of food-material.

During this period great changes took place in the tissues of the leaf. The petiole increased in diameter, as also the lamina in thickness by about one-third. The vascular bundles of the petiole had increased three to four fold in size, but without any development of sclerenchymatous elements. In the lamina, the palisade-tissue had increased to more than one-half the entire thickness of the leaf, the cells increasing greatly in length at right angles to the surface, and then dividing by septa parallel to the surface. This was especially the case with the parenchyma of the upper surface of the leaf.

Leaves of Grasses.†—Herr M. Güntz has examined the structure of the leaves of 132 species of grass with reference to their habit and mode of life. He finds that, as a rule, xerophilous grasses have erect narrow leaves, often channelled or folded, with strongly thickened cuticle, contrivances for the protection of the stomata by hairs or a coating of wax, and strongly developed tissue for the retention of water. Hygrophilous grasses, on the other hand, and those which grow in the shade, have usually flat leaves with only slightly thickened cuticle, free stomata, without any coating of wax, and, except in tropical species, but slender development of the aqueous tissue. The author further classifies, with respect to their habits and the structure of their leaves in four groups, viz.:—(1) Savannah grasses; (2) Meadow grasses; (3) Bamboos; and (4) Steppe grasses.

Coloured Leaves.‡—From an examination of the anatomical structure of a large number of coloured and variegated leaves, and of the physiological properties of their pigments, Dr. C. Hassack concludes that the white colour in variegated leaves results from the absence of pigment in the tissues, and the presence of numerous interstices filled with air between the cells; the reflection of light from the numerous air-bubbles in them causes the parts of the leaf which are really colourless to appear white. In leaves with yellow variegation, the normal chlorophyll is replaced by xanthophyll, which colours light-yellow the protoplasm collected into irregular parietal lumps, and occurs also in the form of minute granules. The grey-green, which often appears in coloured leaves in addition to white, is caused by white layers of tissue which lie above the green parts of the cells and partially obscure their colour. Silver-white spots on leaves with a metallic shimmer, are the result of an entire reflection of the light from large shallow air-cavities, which stretch between the colourless and the green layers of tissue in a direction parallel to the surface of the leaf. Red and brown tints are caused by the presence of anthocyan dissolved in the cell-sap, partly in the epidermis only, partly in the parenchyma only, partly in both tissues. The various tints depend on the intensity of the colour, and the concurrence of red cells with green, yellow, or white portions of tissue. A papillose structure of the epidermis, peculiar trichomes, or, in a few cases, a wavy structure of the entire leaf, is the cause of the velvety sheen of

* Bull. Soc. Bot. France, viii. (1886) pp. 136–41.

† Güntz, M., 'Unters. über d. anatom. Structur der Gramineenblätter,' 70 pp. and 2 pls., Leipzig, 1886. See Bot. Centralbl., xxviii. (1886) p. 201.

‡ Bot. Centralbl., xxviii. (1886) pp. 84–5, 116–21, 150–4, 181–6, 211–5, 243–6, 276–9, 308–12, 337–41, 373–5, 385–8 (1 pl.).

many leaves; the apices of the papillæ have the effect of bright points on a dark ground, the light being reflected from them in one direction only, while their lateral surfaces scatter the light.

While albinism is the result of degeneracy, Dr. Hassack regards a red colour as a direct consequence of light, and as a contrivance to protect leaves from the destructive action of too strong light on the chlorophyll, and too strong respiration; it is hence found especially in young leaves, or in the leaves of those plants which grow in very high altitudes, or in very cold latitudes.

Relationship of the Anatomical Structure of Leaves to their Origin.* —M. L. Dufour states that, in those leaves in which the normally upper and under surfaces become reversed in the course of growth, either the anatomical characters of the two surfaces become completely changed with their relative position, or some of the original differences remain unchanged. The former is the case with *Alstrœmeria psittacina* and *Allium ursinum*, the latter with *Allium nutans* and other species, *Eustrephus angustifolius*, and a large number of grasses. The fibrovascular bundles never undergo any change of position or of structure with the reversal of the position of the leaves; the characters most liable to change are the distribution of the stomata, the position of the palisade-parenchyma, and the relative degree of hairiness.

Petiole as a Taxonomic Organ.†—According to M. L. Petit, a transverse section of the terminal portion of the petiole may, within certain limits, be used for the purpose of determining the natural order to which a plant belongs. The following are the principal variations in its characters:—A. The transverse section exhibits secreting canals; *a*, a certain number of these canals are arranged regularly behind the peripheral bundles; (1) no crystals, bundles isolated, near the epidermis (Umbelliferæ); (2) usually macles, bundles isolated or united into a ring, near the centre (Araliaceæ; *Hydrocotyle* is intermediate between these two); *b*, secreting canals arranged irregularly; (1) macles, bundles united into a ring (some Malvaceæ); (2) no macles, bundles distinct (some Compositæ). B. The transverse section exhibits no secreting canals; *a*, bundles bicollateral; (1) median bundle well developed; *a*, laticiferous tubes (Asclepiadeæ, Apocynaceæ); *β*, laticiferous cells arranged in rows (Convolvulaceæ); *γ*, no laticifers, crystalline granulations (Solanaceæ); *δ*, no laticifers, macles (Myrtaceæ); (2) bundles nearly equal, no crystals; *b*, no bicollateral bundles; (1) macles, under this class are included a large number of minor variations; (2) no macles, *a*, numerous crystalline granulations in the same cell (some Chenopodiaceæ); *β*, crystals solitary (some Leguminosæ); *γ*, no crystals (to this class again belong a number of varieties, distinguished by smaller differences).

The author suggests that these characters may be useful in assisting to determine the position of fossil plants.

Structure and Physiology of Stomata.‡—Dr. H. Leitgeb has tried the experiment of separating the guard-cells of stomata from the adjacent epidermal cells and subjecting them to the action of stimuli, to which he found them very sensitive, and capable also of preserving their vitality for an extraordinarily long period. The experiments were made chiefly on the epidermis of the perianth-leaves of *Galtonia candicans*, in which the posterior wall of each guard-cell is connected with the opposite wall of the

* Bull. Soc. Bot. France, viii. (1886) pp. 268–75.
† Comptes Rendus, ciii. (1886) pp. 767–9.
‡ MT. Bot. Inst. Graz, i. (1886) pp. 123–84 (1 pl.).

adjoining epidermal cell by strands of cellulose, which afterwards become cuticularized.

In accordance with previous observations, he finds that, under normal conditions, the stomata are always open in bright daylight, the opening being effected by the turgidity of the guard-cells. It must not, however, be assumed from this that the turgidity of the guard-cell decreases at night, since in all the other cells it increases. In *Potamogeton natans* he found the guard-cells always open at night under normal conditions, this being the result solely of the turgid condition of the adjacent cells. The stomata of native Orchideæ and native Liliaceæ exhibit the peculiarity of opening instead of closing in water, this resulting from the ordinary epidermal cells losing their vitality much sooner than the guard-cells. In these plants the stomata do not close at night.

With regard to the closing of stomata at night, Dr. Leitgeb finds that, in contrast to the large number of plants in which the stomata are closed at night, there are certainly not fewer in which, under the same vital conditions, they do not close. All plants do not show the same phenomena when light is artificially shut out for a short time; the stomata may either close completely or not. Even in nature, however, plants belonging to both these categories do not behave alike; and in some the opening or closing of the stomata in light or darkness can be brought about at pleasure. In all circumstances the stomata close as the result of too great dryness of the soil, and commonly, even before the plant is observed to wither. In some plants the stomata partially close in direct sunlight, even with an abundant supply of water. In many, when the soil is sufficiently moist, the condition of the stomata is determined by the degree of moisture of the surrounding air, and is altogether independent of light. But all plants do not behave alike in this respect; an atmosphere saturated with moisture is unfavourable in some, while it promotes in others the closing of the stomata. It is therefore probable that the closing of the stomata at night is, where it takes place, not an immediate result of the withdrawal of light, which causes a decrease in the turgidity of the guard-cells; but that it is brought about by the lateral pressure of the epidermal cells against the stoma, which pressure increases with the increasing turgidity of the plant or of the organ which bears the stomata.

Anatomy of Stipules.*—M. G. Colomb proposes to define the term stipule more exactly than heretofore as any appendicular organ inserted on the stem, the vascular system of which is formed exclusively of branches of the foliar bundles before these have emerged from the cortex. He illustrates this definition in the cases of the hop, *Viola tricolor* and *striata*, *Galium*, *Rubia*, the honeysuckle, *Centranthus*, *Sambucus*, and others.

Peltate Hairs.†—Herr O. Bachmann has examined the structure of the peltate hairs in a large number of species belonging to many different orders. The commonest form, which he regards as the typical, is where each cell has the form of a narrow wedge, all these wedges radiating from the centre and united into a single plate, with or without a distinct stalk.

This may be varied by the cells being conically elevated in the centre, giving a cup-like form to the structure, or divided by cell-walls in different directions, or by the centre being modified in various ways. Thus, instead of being a point, it may be a line; or it may be raised into a globular form. The cells of which the peltate structure is composed may consist of two or more layers; or, on the other hand, it may be composed of two cells only.

* Bull. Soc. Bot. France, viii. (1886) pp. 288–94 (6 figs.).

† Flora, lxix. (1886) pp. 387–400, 403–15, 428–48 (4 pls.).

In some instances it is composed of two sets of cells, those springing from the centre not reaching the margin, and those springing from the margin not reaching the centre.

Herr Bachmann describes the peculiarities of these hairs in the various species examined, and discusses the value of characters derived from them for the purpose of classification.

Zygomorphy of Flowers.*—Herr H. Vöchting distinguishes three different sets of causes as producing zygomorphy in flowers, viz.:—(1) Gravitation only, (2) gravitation acting on the constitution of the organs, (3) the constitution of the organs alone. In the first type, which he terms zygomorphy of position, the flowers are always at first actinomorphic or regular, becoming subsequently zygomorphic. In all the plants examined belonging to this type, with the exception of *Epiphyllum truncatum*, the flowers are lateral, and all the members of the same whorl are affected by geotropism of the same kind, positive or negative. In that species the flowers are terminal, and it exhibits in other ways exceptional phenomena. Closely connected with the form of the flower is the curvature of the flower-stalk. Plants very closely allied to one another exhibit the greatest differences in the mode in which their zygomorphy is manifested. The curvature of the stalk is sometimes the result of inner, sometimes of outer causes; and with the same origin on the axis, and the same horizontal position of their own larger axis, the flowers are sometimes actinomorphic, sometimes zygomorphic, the latter property being sometimes produced by gravitation, sometimes by internal causes.

Double Flowers.†—Herr K. Goebel discusses the question of the doubling of flowers, chiefly from a horticultural point of view, and gives the results of a large number of observations. These observations, chiefly those made on *Leucojum*, show that from stocks with single flowers, seeds can be obtained by selection which will produce a larger and larger proportion of individuals with double flowers up to even 90 per cent. or still more; and from this he draws the conclusion that there must be a tendency towards doubling in the seeds borne by single flowers. The seeds which will produce double flowers can be distinguished by their smaller size and abnormal forms, from those which will produce ordinary single flowers. The various modes of doubling are described, resulting from the reversion of stamens to the condition of petals and from the increase in the number of petals or of corolline whorls.

Ovuliferous Petals in Caltha palustris.‡—M. L. Mangin calls attention to examples of flowers of this plant possessing two small supplementary petals [sepals] within the ordinary ones, which bore on their margins one or two rows of small buds. Each of these buds consisted of a nucellus protected by an integument and containing an embryo-sac, in which could be detected an oosphere, two synergidæ, antipodal cells, and a vegetative nucleus.

Inferior Ovaries.§—Herr K. Goebel discusses the two views as to the development of the inferior ovary: that of Koehne and Van Tieghem, that it is the result of coalescence of the basal portions of the sepals, and that of Schleiden, Payer, Hofmeister, and Sachs, that it arises from a hollowing out of the receptacle before the foliar organs have begun to be

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 297–346 (5 pls.). Cf. this Journal, 1886, p. 472.

† Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 207–96 (5 pls.).

‡ Bull. Soc. Bot. France, viii. (1886) pp. 262–3.

§ Bot. Ztg., xliv. (1886) pp. 729–38 (1 pl.).

formed. From an examination of the history of development of the inferior ovary of Compositæ and the superior ovary of Nymphæaceæ and Ranunculaceæ, and a comparison of the inferior ovary of Umbelliferæ with the superior ovary of *Acer*, he comes to the conclusion that in the inferior ovary there is no true coalescence of sepals; but on the other hand, the foliar organs do take part in the formation of the cavity even of the inferior ovary. He further disputes that there is any essential difference between the true inferior ovary and the so-called apparently inferior ovary of the Pomaceæ.

Extra-floral Nectaries of Hodgsonia heteroclita.*—Mr. W. Gardiner describes the gland-bearing organs which are found in *Hodgsonia*, one in the axil of each of the foliage leaves. A study of the development of these organs demonstrates that they are peculiarly modified leaves, or rather bracts, since they are associated with the rudimentary flower-bud. They are doubtless identical with the similar modified bracts which occur in connection with the fully developed flowers. The glands are found on the lower surface of the bract, and belong to the same type as those of *Luffa*, although of a distinctly higher order. Glands of a similar nature also occur on the under surface of the foliage leaves and on the sepals. The substance secreted by the glands is most probably of the nature of nectar, and the whole structures are to be regarded as extra-floral nectaries.

A careful survey of the various gland-bearing genera of the Cucurbitaceæ and Passifloraceæ, and a comparison of such cases as those presented by *Passiflora quadrangularis* and *P. fœtida*, place it beyond doubt that the function of the extra-floral nectaries of the two orders is to attract certain insects—probably ants—which are of service to the plant in protecting it from the attacks of other and harmful insects, such as caterpillars. As regards the fertilization of *Hodgsonia*, there are special contrivances to prevent the animal which feeds upon the nectar of the flower from obtaining that of the extra-floral nectaries, and *vice versâ*; it is exceedingly probable that fertilization is accomplished through the agency of a large night-flying moth.

Extra-floral Nectaries of Amygdaleæ.†—Sig. L. Macchiati describes the nectariferous glands on the young leaves of *Persica vulgaris*, *Amygdalus communis*, *Prunus domestica*, and *Cerasus vulgaris*. The size of the nectaries varies with the time of day, the maximum size being early in the morning, and the minimum in the afternoon. While in tropical America the purpose of extra-floral nectaries is to attract destructive ants of the genus *Œcodoma*, those of European plants serve in most cases to protect the flowers against the attacks of caterpillars. On the mature leaves the glands have altogether disappeared.

Succulent Fruits.‡—Dr. P. Lampe classifies the various kinds of succulent fruits into (1) berry, (2) drupe, and (3) pseudocarp (forms of *Cratægus*, *Mespilus*, *Cotoneaster*, and *Sorbus*), and describes the peculiarities of the special structure in the cases of a number of wild and cultivated species.

Contrivance for dispersing the Fruit of Scutellaria galericulata.§—Dr. M. Kronfeld calls attention to a structure peculiar to this plant among Labiatæ. The nucules of which the fruit is composed are one after another ejected through the tube formed by the upper part of the persistent calyx,

* Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
† Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 305–7.
‡ Zeitschr. f. Naturwiss, v. (1886) pp. 295–323.
§ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvi. (1886) pp. 373–5 (4 figs.).

this purpose being assisted by the elasticity of the fruit-stalk. The ejection of the nucules in a particular direction is secured by this contrivance.

Raphides-cells in the Fruit of Vanilla.*—As a general rule, the raphides-cells in the stem and leaves of Monocotyledons are characterized by preserving their division-walls intact. M. L. Guignard has noticed that in the ovary of *Vanilla aromatica* are cells arranged in rows containing a gummy matter and bundles of crystals of calcium oxalate. The walls which separate these cells from one another have in many cases disappeared owing to their perforation by the raphides.

Efficiency of the defensive structures of Plants.†—Dr. L. Errera classifies the means of protection of plants against animals under three heads:—(*a*) biological, (*b*) anatomical, and (*c*) chemical. Under the first he places those plants which grow in inaccessible situations, or by their dense growth form impenetrable thickets, or those which owe their existence to protective resemblance. Under the second head come spines, prickles, stings, &c., and the various modifications by which plants become hardened, thereby rendering them unfit for animal food. In the third division are the various chemical substances contained by plants, i. e. acids, tannins, essential oils, bitter principles, glucosides, alkaloids, &c.

The author also classifies plants into those which are sought after, shunned, or neglected by animals. Taking his examples from the Belgian flora, the author gives the percentage of the genera which come under each heading. With coriaceous or scabrous plants, 49 per cent. of the genera are shunned; with prickly or stinging plants, 35 per cent.; with plants containing an essential oil, 44 per cent.; with plants containing a bitter principle, 26 per cent., a glucoside, 28 per cent., and an alkaloid, 9 per cent. The percentage of the genera of those which are sought after is between 35 and 41; the remainder being those that are neglected.

In conclusion the author hopes that this much-neglected branch of botany will not be overlooked in the future, those plants showing protective resemblance being worthy of special study.

β. Physiology.‡

(1) Reproduction.

Reproductive Organs of Hybrids.§—The sterility of hybrids is exhibited more frequently in the imperfect development of the male than of the female organ. M. L. Guignard has studied the structure of pollen-grains when atrophied through the agency of hybridity. Where the stamens are not converted into staminodes, their arrest of development may be exhibited in various degrees. Very frequently the pollen-grain has only a single nucleus instead of two. The young pollen-grain may then be altogether arrested in its development; or it may put out a tube which penetrates the stigma, but which has only a germinating and no reproductive power, as in some *Begonias*. In other cases the pollen-grain—which may even be larger than the ordinary grain—has both its nuclei, but is still destitute of the power of impregnation. In a few cases there are more than two nuclei.

* Bull. Soc. Bot. France, viii. (1886) pp. 348-50.

† CR. Soc. R. Bot. Belg., 1886, pp. 86-104.

‡ This subdivision contains (1) Reproduction (including the formation of the Embryo and accompanying processes); (2) Germination; (3) Nutrition; (4) Growth; (5) Respiration; (6) Movement; and (7) Chemical processes (including Fermentation).

§ Comptes Rendus, ciii. (1886) pp. 769-72.

The ovules also, though apparently of normal size and form, usually display some degree of functional atrophy. In hybrid *Begonias* in which the stamens are transformed into staminodes, the ovules are destitute of an embryo-sac. In other cases, even when the number of ovules is reduced below the normal, they still retain their fertility when the pollen-grains have become altogether sterile.

Hybrid-pollination.*—Prof. E. Strasburger gives the results of a large number of further experiments on the extent to which pollen-grains from one species will germinate on the stigma of another species. His observations and experiments have led him to the conclusion that the pollen-grains contain a diastatic ferment, which can often be readily recognized by its rapid and energetic action on starch-paste. This ferment appears to be of the greatest importance to the nutrition of the pollen-grains as their tubes pass through the tissue of the style. It is probable also that there are other ferments which have the property of attacking cellulose, that it is the action of this ferment which enables the pollen-tube to pierce cell-walls, and that the nature of the ferment must differ in different species. The action is probably the same in the hyphæ of parasitic fungi which penetrate the host. The same explanation may be offered of the penetration of the pollen-tube into the embryo-sac, and of the general capacity for pollen-grains to impregnate only ovules belonging to their own species.

Vitality of Pollen-grains.†—M. L. Mangin has experimented on this subject with pollen-grains from a number of different species, when germinating both naturally and on specially prepared nutrient solutions. For the latter he finds a convenient preparation to be agar-agar softened and dissolved in boiling water, glucose, saccharose, gum, or dextrin being then added. The period during which the pollen-grains retain their power of germination varies between one day in the case of *Oxalis Acetosella*, and eighty days with *Narcissus pseudo-narcissus* and *Picea excelsa*. As a general rule the germinating period is short for those species which remain in blossom for a long while. The rapidity with which the grains germinate after coming in contact with the nutrient fluid also varies, some putting out their tubes immediately, others not till after the lapse of several days. Light has a favourable effect on the growth of some pollen-grains, an unfavourable effect on others.

Fertilization of Achlys triphylla.‡—Dr. S. Calloni describes the structure of the flower of this species, a native of western North America, which differs from the typical Berberideæ in being dichogamous and in the absence of a nectary, and apparent absence also of a corolla. In the first two of these points it approaches the Lardizabaleæ. It is proterandrous and anemophilous.

Fertilization of Aconitum Lycoctonum.§ — According to Herr C. Aurivillius the flowers of this plant are dimorphic, some having the spur straight, others curved upwards into nearly a semicircle. The plant is strongly proterandrous, and is visited largely by humble-bees, and apparently hardly at all by any other insects. Of these some have a proboscis too short to reach the nectary at the base of the spur; these bite through

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 50–9 (1 fig.). Cf. this Journal, 1886, p. 279.

† Bull. Soc. Bot. France, viii. (1886) pp. 337–42.

‡ Arch. Sci. Phys. et Nat., xvi. (1886) pp. 452–9.

§ SB. Bot. Sällsk. Stockholm, Feb. 17, 1886 (2 figs.). See Bot. Centralbl., xxix. (1887) p. 125.

the spur, and take no part in the fertilization of the ovules, which is effected only by long-styled bees.

The author points out the great difference in structure between the proboscis of a humble-bee and that of a butterfly, the former being able to turn the tip about in all directions, and thus obtain the honey from a spur even when its apex points upwards, which is not the case with Lepidoptera.

Fertilization of Cactaceæ.*—In opposition to the assertion of Kruttschnitt,† M. L. Guignard states, from observations on several species of *Cereus*, that fertilization is effected in the ordinary way by the pollen-tubes penetrating the conducting tissue of the style and entering the micropyle of the ovules. The structure of the ovary and ovules presents, however, several peculiarities. The very long funicles branch, in *C. tortuosus*, into as many as thirty branches or secondary funicles, each terminating in an ovule. The campylotropous ovules are thus brought into the very centre of the ovary, and the conducting tissue of the ovary consists of a number of papillæ or hairs containing starch-grains, which clothe the concave side of the primary and secondary funicles. In *C. tortuosus* not more than one-twentieth of the ovules are impregnated. M. Guignard was unable to detect any perforations or punctations at the apex of the pollen-tube, and believes that the passage of its contents into the oosphere takes place by diffusion. He regards the synergidæ as playing an essential part in the impregnation of the oospheres, though their exact function is still uncertain. In *C. tortuosus* it may be as much as three weeks after pollination before the pollen-tubes reach the ovules.

Fertilization of Cassia marilandica.‡—Mr. T. Meehan describes the mode in which the flowers of this plant are fertilized by humble-bees, the only mode in which fertilization can take place. The anthers do not split longitudinally, but have a terminal pore, covered by a membrane; the bees burst this membrane, and force out the pollen through the open pore. Mr. Meehan maintains that the dependence of a plant on insect aid for fertilization is an indication that its race is nearly run, and that it is on the downward track in the order of nature.

(2) Germination.

Loss of Nitrogen by Plants during Germination and Growth.§—Mr. W. O. Atwater and Mr. E. W. Rockwood give the details of some experiments, which consisted in causing peas to germinate under appropriate conditions, and cultivating the germinated plants for a longer or shorter time in water or sand. The nitrogen in the seed at the outset was estimated by determining the nitrogen in other peas in the same lot; in the germinated seeds or young plants it was determined directly. The general conclusions arrived at may be summarized as follows:—

(1) The decomposition of nitrogenous organic matter, living and dead, and of nitrates as well, is often attended by the evolution of nitrogen in either the free state or in its compounds, or in both. This liberation of nitrogen is sometimes, if not always, due to microbes.

(2) The germination of seeds is sometimes, but not always, accompanied by loss of considerable quantities of nitrogen. The balance of evidence seems decidedly to favour the hypothesis that germination without microbes and without the liberation of nitrogen is the normal process.

* Bull. Soc. Bot. France, viii. (1886) pp. 276–80.
† See this Journal, 1885, p. 270.
‡ Proc. Acad. Nat. Sci. Philadelphia, 1886, pp. 314–3.
§ Amer. Chem. Journ., viii. (1886) pp. 327–43.

(3) In this view both the action of microbes and the liberation of nitrogen either in the free state, or in the lower oxides or ammonia, must be regarded as simply forms of decay. They would thus be not essential to germination and growth, but accessory phenomena like the zymotic diseases that attack higher organisms.

Effects of the Temperature of Melting Ice on Germination.* — From experiments performed on a number of seeds, M. C. De Candolle concludes that it is impossible for germination to take place at the freezing-point when care is taken that there be no local heating of the soil in contact with the seeds themselves.

Desiccation of Seeds of Aquatic Plants.†—Prof. F. Ludwig calls attention to Fritz Müller's observation, that the seeds of some aquatic plants, such as *Eichhornia* and *Heteranthera*, seemed to require desiccation as a preliminary to germination. Some seeds of *Mayaca fluviatilis*, dried for six weeks during their conveyance from F. Müller to Professor Ludwig, germinated immediately after being sown, while others of the same lot, sown directly in water by F. Müller, had made no progress even after the lapse of three months. A. Braun noted a similar necessity for desiccation in the alga *Chlamydococcus pluvialis*. Fritz Müller notes the case of *Pistia*, where it seems that the seed must come to the surface and in contact with the air before germination; if this be prevented by entanglement, &c., germination does not take place.

Birds as Disseminators of Seeds.‡—Sig. A. Piccone records a list of twenty-three species of plants, natives of Liguria, nearly all trees and shrubs, the seeds of which are disseminated by passing through the body of birds and being voided with the excrements. He notes that the gizzard is wanting in the greater number of birds of passage and in those which live on insects or on soft and fleshy fruits.

(4) Growth.

Correlation of Growth.§—Dr. M. Kronfeld gives examples of Goebel's law of correlation of growth, viz. that if any organ is suppressed, the organ dependent on it will grow more vigorously in order to make up the loss. He found this to take place to a remarkable extent with the stipules of *Vicia Faba* when the leaves had been removed. With the small narrow stipules of *Phaseolus multiflorus*, *Rosa semperflorens*, *Rubus fruticosus*, and *Idæus*, *Sida Napæa*, *Trifolium filiforme*, *Urtica urens*, and the leafy auricles of *Pyrethrum indicum*, no corresponding increase took place. In *Pyrus Malus*, in one experiment out of five, one stipule increased in superficies about 100 per cent. With *Pisum sativum* the leaves and stipules each grew more rapidly when the other was removed, and flowers were produced in both instances.

Terminal Growth of the Root in Nymphæaceæ.‖—In addition to the points of difference already recorded between the Nelumbeæ and the true Nymphæaceæ, M. P. Van Tieghem points out that in the former the root-cap and piliferous layer of the root are derived from the same initial cells, which are independent of those of the cortex; while in the latter the root-cap is altogether independent in its origin of the piliferous layer which proceeds from the same initial cells as the cortex. This point is of con-

* Ann. Sci. Phys. et Nat., xvi. (1886) pp. 322–3.
† Biol. Central., vi. (1886) pp. 299–300.
‡ Nuov. Giorn. Bot. Ital., xviii. (1886) pp. 286–91.
§ Bot. Ztg., xliv. (1886) pp. 846–9.
‖ Bull. Soc. Bot. France, viii. (1886) pp. 264–5.

siderable importance, since the latter relationship had hitherto been observed in Monocotyledons only.

Gliding Growth in the Formation of the Tissues of Vascular Plants.*—The term "gliding growth" (gleitendes Wachsthum) is applied by Herr G. Krabbe to that mode in which the cell-walls of neighbouring cells become pushed or glide one over another; and he points out the importance of this process in the differentiation of tissues. Any increase in the tangential diameter of vessels can, he maintains, take place only on this supposition. A very simple instance of this mode of growth occurs in the formation of the cambium-ring. The author believes also that it assists in the formation of vascular cells, sieve-tubes, tracheïdes, libriform, and bast-cells. When cells increase in volume in this way, no increase in turgidity need be assumed, the cause of growth being an active growth or specific activity of the cell-wall where it is in contact with the protoplasm. This view is inconsistent with the hypothesis of a universal continuity of protoplasm from cell to cell.

Influence of an Aquatic Medium on Amphibious Plants.—M. E. Mer,† replying to the objections of Costantin,‡ adheres to his conclusion that modifications which survive in the form and structure of amphibious plants in consequence of a change of medium—the only ones on which it is possible to experiment, because they are the only ones which can survive in either air or water—must be considered as the result—not of a direct influence, but of a slow and prolonged action of the medium, transmitted by heredity. He supports this view from the structure of the very plants which Costantin relies on to prove the contrary.

To this M. J. Costantin replies, § adducing instances in which he conceives that no other explanation can be offered of the alteration of structure in organs caused by complete submersion than that it is the direct result of the action of the medium on the organs.

(6) Movement.

Transpiration. ‖—Herr F. G. Kohl enters in great detail into the phenomena attending this function. In opposition to the statements of Haberlandt and Wiesner, he finds that cut plants when moistened wither less rapidly than when dry. Moistening with water causes the stomata to close or not, according to the structure of the neighbouring epidermal cells. When the guard-cells are the only epidermal cells which contain chlorophyll, the stomata open in light; but if the other cells of the epidermis also contain chlorophyll, the effect is slight or none at all. With regard to the influence of temperature on the stomata, the author confirms the observations of Schwendener and Sorauer that a rise in temperature favours transpiration, whether of the air or of the ground. Plants destitute of stomata, as *Trichomanes radicans*, transpire less in the dark than in diffused light.

A number of experiments were undertaken in order to ascertain the effect of stronger or weaker transpiration on the development of tissue. As a general result it is stated that plants grown in dry air exhibit a tendency to stronger thickening and cuticularizing of the outer walls of

* Krabbe, F., 'Das gleitende Wachsthum bei der Gewebebildung d. Gefässpflanzen,' 100 pp. and 7 pls., Berlin, 1886. See Bot. Centralbl., xxix. (1887) p. 3.

† Bull. Soc. Bot. France, viii. (1886) pp. 169–77.

‡ See this Journal, 1886, p. 474. § Op. cit., pp. 192–6.

‖ Kohl, F. G., 'Die Transpiration d. Pflanzen, u. ihre Einwirkung auf d. Ausbildung pflanz. Gewebe,' 124 pp. and 4 pls., Braunschweig, 1886. See Bot. Centralbl., xxviii. (1886) p. 292.

the epidermal cells; these cells are elongated in a radial direction, while they lengthen rather in the tangential direction when grown in moist air; in the former case the outer parenchymatous cells of the cortex are usually strongly collenchymatous, only slightly in plants grown in moist air; the bast-fibre-bundles and xylem-portions are more strongly developed, the vessels especially being larger, and having thicker walls. The conditions of transpiration not only affect the quantity of different tissue, but cause the actual formation or disappearance of tissues. Plants grown in moist air have usually longer internodes and leaf-stalks, less indented leaves, and less hairiness.

The author maintains that the transpiration-current takes place in the cavities, and not in the membrane of the xylem-elements.

Chlorovaporization.* — M. P. Van Tieghem calls attention to the difference between the process which he calls by this name, and transpiration. The latter is a function of all living beings, and of all parts of plants whether containing chlorophyll or not, and takes place in darkness as well as in light, though it is promoted both by light and by a high temperature. Chlorovaporization, on the other hand, is a function belonging exclusively to chlorophyll, taking place only from the chloroleucites, and only under the influence of rays of light of a certain refrangibility. It is, in fact, a purely physical phenomenon independent of vital energy, and is much more nearly allied to the assimilation of carbon than to true transpiration; it is probable that, like assimilation, it would be completely arrested by the action of anæsthetics, while transpiration is not suspended by them.

Influence of Cold on the Movements of the Sap.†—By the use of the manometer, especially in the case of the sycamore tree, M. Leclerc du Sablon has established that during periods of frost, whenever a higher temperature thaws the sap, the pressure is unusually great, but varies greatly in different parts of the tree. During days of thaw, the pressure becomes very strong towards the middle of each day, decreasing then rapidly towards evening. On days when the temperature is more uniform, either warm or very cold, the pressure is also more uniform. If the stem is wounded under these conditions, the sap escapes in abundance.

The explanation usually given to the similar phenomenon of weeping, viz. root-pressure, or the endosmotic force in roots, hardly appears to serve in this case.

(7) Chemical Processes (including Fermentation).

Inversion of Sugar by Pollen-grains.‡—M. P. Van Tieghem shows, by renewed experiments, in the cases of the pollen of the crocus, hyacinth, narcissus, wallflower, and violet, the power of converting sugar into inverted sugar. This inversion exists ready formed in ripe pollen-grains. The same result, though in a feebler degree, is produced by the spores of *Lycopodium*, and of some ferns. The quantity of invertin present in some pollen-grains must be very considerable, judging by the small amount of pollen required to produce a considerable quantity of glucose.

γ. General.

Symbiotic Formations.§—Herr A. N. Lundström distinguishes between such examples of symbiosis as are antagonistic (cecidia), and such as are

* Bull. Soc. Bot. France, viii. (1886) pp. 152–5. † Ibid., pp. 208–11.
‡ Ibid., pp. 216–8.
§ SB. Naturvet. Studentsällsk. Upsala, Sept. 28, 1886. See Bot. Centralbl., xxviii. (1886) p. 282.

mutual (domatia). The former are again divided into zoocecidia, produced by animals, and phytocecidia, caused by the attacks of plants. The last again include mycocecidia, due to the attacks of fungi, such as *Synchytrium*, and phycocecidia, e. g. the cephalodia of lichens. Domatia, again, may be zoodomatia or phytodomatia; among the former are the peculiar formations on myrmecophilous plants, and acarodomatia, structures which serve for the habitation of acari. Examples of mycodomatia occur in the swellings on the roots of Leguminosæ, and of phycodomatia in the hollows in the leaves of *Azolla*.

Phytoptocecidia.*—Herr F. Löw describes eleven new galls produced by parasitic fungi on *Achillea nana*, *Anchusa officinalis*, *Galium infestum*, *G. lucidum*, *Gentiana rhætica*, *Lycium europæum*, *Rubus Gremlii*, *Sedum album*, *Sempervivum hirtum*, *Seseli hippomarathrum*, and *Vitex agnus-castus*.

Parasitism of Heterodera javanica.†—Herr M. Treub has detected on the roots of the sugar-cane a new species of nematode, to which he gives the above name, and which is nearly allied to *H. radicicola*, but distinguished by its smaller size. Each gall usually contained several (female) nematodes. Near the head of the parasite were always observed some large cells containing a large number of nuclei. A similar hypertrophic effect has been observed in other cases as the result of the attacks of parasites.

Diseased Potato.‡—M. J. B. Schnetzler describes a potato of abnormal form, 15 cm. long; on its surface were four tubercules, each having a diameter of five to six cm. After having been laid in a cabinet all the winter, a white mould developed on its under surface, which was recognized as *Phytophthora infestans*. On making a section of one of the tubercules, the tissue was found to be overrun with the mycelium of *Phytophthora*, together with a quantity of *Fusisporium Solani*. In the buds a colouring matter, anthocyan, was found, behaving exactly like litmus with acids and alkalies.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Leaf-stalk of Ferns.§—Herr K. Thomae has made an exhaustive examination of the leaf-stalk of ferns; in reference, firstly, to the various points of structure, viz. the epidermal tissue, the mechanical tissue, the receptacles for secretions, the aerating system, the fundamental parenchyma, and the vascular bundles; and secondly, to the different groups into which the order is divided, viz.:—(1) Marattiaceæ; (2) Osmundaceæ; (3) Cyatheaceæ; (4) Polypodiaceæ, with its subdivisions; (5) Gleicheniaceæ; (6) Schizæaceæ; and (7) Hymenophyllaceæ.

One main result is to bring into prominence the differences between the Marattiaceæ on the one hand, and all the other families of ferns on the other hand. In the latter there are no medullary vascular bundles; all lie, in transverse section, on a single curve, which often, in its windings, approaches the centre of the stalk. Those bundles, on the other hand, in the Marattiaceæ which lie within the peripheral circle may be correctly termed medullary. In the composition of the tissues there are also important differences between the Marattiaceæ and true ferns.

* Verhandl. Zool.-Bot. Gesell. Wien, xxxv. (1885) pp. 451–70.

† Ann. Jard. Bot. Buitenzorg, vi. (1886) pp. 93–6 (1 pl.). See Bot. Centralbl., xxviii. (1886) p. 269.

‡ Bull. Soc. Vaud., xxii. (1886) pp. 143–4.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 99–161 (4 pls.).

As regards any system of classification derived from anatomical characters, the separate families show in general a characteristic structure, and this is sometimes also the case with individual genera; but a general classification of all ferns cannot be established in this way. The author considers also that the examination of the leaf-stalk cannot be employed for purposes of classification in palæontology, since it is usually only a fragment that can be examined, with respect to which it is unknown to what height in the stalk it belonged.

Paleæ of Ferns.*—Herr E. Goebeler describes the mode of development and structure of the trichomes of ferns. They originate from older segments of the apical cell of the stem, in which longitudinal, transverse, and tangential septa have already been formed. Subsequently they may develope either into a filament of cells constituting an ordinary hair, or more commonly, by longitudinal divisions into a flat plate of cells, a wedge-shaped apiculate palea or ramentum, the base occasionally remaining unicellular. In some cases there is a central row of elongated cells, a rudimentary mid-rib, which may even divide, by septa parallel to the surface, into several rows of cells from which branches occasionally proceed; in *Asplenium Trichomanes* the mid-rib is especially well developed. The margin of the palea is very commonly glandular or serrate; much more rarely is there a terminal gland. Only after the cells of the trichome have attained their full development do their walls become brown and thickened. Drops of oil and starch-grains are frequently found in the protoplasm of the cells, but never chlorophyll; in *Struthiopteris germanica* there are numerous crystals of calcium oxalate.

In the young frond the paleæ form a close felt, completely concealing it, and forming a protection against mechanical injury, too much moisture, and changes in temperature. They also especially serve as a reservoir of moisture in the case of a large number of ferns which grow in dry situations or as epiphytes; the tannin which they contain greatly assisting in this.

Pilularia.†—Mr. J. G. Baker completes his monograph of the Rhizocarpeæ with a description of the six known species of *Pilularia*, the most important distinguishing character being the number of cells into which the conceptacle is divided.

Muscineæ.

Reproductive Organs of Muscineæ.‡—Herr S. O. Lindberg gives a *résumé* of the important points in the structure of these organs in Musci and Hepaticæ, viz. the inflorescence male and female, the archegonia, antheridia and antherozoids, the calyptra, and the sporophore, composed of the calceolus, which, buried in the disc of the inflorescence, serves to fix the sporophore, and to absorb the nutriment required by the sexual plant, and the capsule or theca with its spores.

Peristome of Bryum.§—In the present portion of his 'Études sur le péristome' M. Philibert treats of those species of the section Cladodium of *Bryum*, in which the ventral plates of the teeth show a tendency to divide, by a larger or smaller number of accessory septa. These seem to form a natural section, divided into two groups; in the first the peristome precisely resembles that of *B. pendulum*, the greater number of the ventral

* Flora, lxix. (1886) pp. 451–61, 476–81, 483–97 (1 pl.).
† Journ. of Bot., xxiv. (1886) pp. 381–2. See this Journal, 1886, p. 1020.
‡ Rev. Bryol., xiii. (1886) pp. 87–94, 100–9.
§ Ibid., pp. 17–27, 81–6; xiv. (1887) pp. 9–11.

plates being divided into several well-marked compartments. To this group belong *B. pendulum*, *Warneum*, and *Brownii* (not *B. Lorentzii*, as the author had previously believed); also *B. Moei* Sch. and *B. Kaurini* sp. n., intermediate between the two latter.

The second group is that of *B. arcticum*, under which species are included a great number of subordinate forms; it is characterized by the ventral plates of the peristome being divided by a single median septum. In this group the author described at length *B. purpureum* sp. n., *viride* sp. n., *inflatum* sp. n., *helveticum* sp. n. A new species resembling this group in the structure of the peristome, but differing in other characters, is described under the name *B. œlandicum*.

Optical Properties of the Peristome of Mosses.*—If the peristome of *Brachythecium rutabulum* is examined under the Microscope with polarized light, M. J. Amann states that the teeth of the exostome will strongly rotate the plane of polarization, and will become illuminated if seen with crossed nicols. The endostome, on the contrary, does not possess this property. If the peristome of a *Barbula* be examined it will be found to be inactive. This action of the peristome on polarized light varies with the genus; it is feeble in *Pottia* and *Weissia*, rather more active in *Grimmia*, more so in *Dicranum*, and considerably more so in *Mnium* and *Hypnum*. The maximum of activity is observed in *Brachythecium*, *Camptothecium*, &c.

If a tooth from the exostome of *Camptothecium lutescens* be examined with a power of about 500 diameters, it will be seen that it is not the whole surface of the tooth that is illuminated, but that there are bands strongly illuminated alternating with those less so.

The author has found that a curious relation exists between the presence of tannin and the optical properties; those organs which contain the largest percentage of tannin being the most active towards polarized light.

Amblystegium.†—M. R. du Buysson describes thirteen European species of this genus of mosses, and details the characters which distinguish it from *Eurhynchium*, *Brachythecium*, *Plagiothecium*, and the different sections of *Hypnum*.

Insectivorous Hepaticæ.‡—In his monograph of *Physiotium* Herr J. B. Jack describes the arrangement of several tropical species (e. g. *P. cochleariforme* and *giganteum*) for capturing and feeding on insects. The "trap" consists of a sac attached to the base of the ventral edge of some of the leaves. In this sac is a fold which is pierced by an orifice. The inner mouth of this orifice is protected by two small leaves, which effectually prevent any small animals that have entered from passing out again. The bodies of great quantities of insects and crustacea were always found in the cavity thus closed; but the author was quite unable to detect any organ or apparatus for their digestion.

Mastigobryum.§—Herr F. Stephani gives a monograph of this genus of Hepaticæ, with descriptions of several new species. He then enumerates all the known species of the genus, 169 in number, of which 41 are described for the first time. The sexual organs of a large number of the species being unknown, they are necessarily classified from vegetative characters, and he proposes the following 11 classes, viz.:—1, Integrifolia;

* Bull. Soc. Vaud., xxii. (1886) pp. 157–61.

† Buysson, R. du, 'Études sur les caractères du genre Amblystegium,' 1885. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 162.

‡ Jack, J. B., 'Monograph of Physiotium.' See F. Stephani in Rev. Bryol., xiii. (1886) pp. 97–9 (1 pl.). Cf. this Journal, 1886, p. 830.

§ Hedwigia, xxv. (1886) pp. 233–49 (2 pls.).

2, Bidentata; 3, Inæquilatera; 4, Connata; 5, Vittata; 6, Parvistipula; 7, Serrulata; 8, Appendiculata; 9, Fissistipula; 10, Cordistipula; and 11, Grandistipula.

Rabenhorst's 'Cryptogamic Flora of Germany' (Musci).—In parts 4–6 of this work Herr K. G. Limpricht completes the Cleistocarpæ, a new genus *Aschisma* being founded on *Phascum carniolicum*. The second division of the Bryineæ, viz. the Stegocarpæ, is then commenced, the first section of it only, the Acrocarpæ, being at present reached. This section he divides into thirty-eight families, an analytical key of which is given. In the family Weissiaceæ, a new genus *Molendoa* is also formed out of *Anœctangium Hornschuchianum* and *Sendtnerianum*, a new species *M. tenuinervis* being also described. The illustrations are numerous and excellent.

Characeæ.

Rotation in Nitella.*—Mr. W. Whiteleggge describes a species of *Nitella* found in the Paramatta River, Australia, in which some of the internodal cells measured from 7 to 8½ in. in length, probably larger than those of any hitherto recorded. The rotation exhibited in the inner nodal cells differs from that of the stems and leaves, inasmuch as the chlorophyll-granules take part in the general rotation. The protoplasm in the young leaves, when viewed under the Microscope with the edge of the cell in focus, appears as a series of elevations and depressions; and with the higher part of the cell in focus these elevations appear as clear spaces surrounded by small granules. Within the layer of protoplasm there exist large numbers of spherical clusters of needle-like crystals, which circulate along the line of demarcation between the cell-sap and the protoplasm.

Algæ.

Formation of Cysts in the Chlorosporeæ.†—M. F. Gay proposes the general term *cyst* for all cells of non-sexual origin in the green algæ which reproduce the plant by remaining dormant for a period and then germinating (Dauersporen, Ruhesporen, spores durables, spores dormantes, resting-spores, hypnospores, chronospores, aplanospores, akinetes, of various authors). They may be formed in two ways, exogenously by the thickening of the cell-wall and gelification of its outer layers, or endogenously by the contraction of the protoplasmic contents, which then surrounds itself with a new membrane of its own.

In the Conjugatæ the formation of cysts has been observed, especially in species of *Zygnema* growing in dry situations; the filaments break up into fragments and become inclosed in a mucilaginous sheath produced by the gelifying of the outer layers of the cell-wall. Cysts formed under these conditions may preserve their vitality for months. When moisture again penetrates the sheath the dormant cells divide by septa and develope into new filaments.

In the Protococcoideæ M. Gay has observed the formation of exogenous cysts in a species of *Tetraspora* and in one of *Chlamydomonas*. In *T. gelatinosa* they result from the encysting of zoospores. A similar process takes place in *Ulothrix tenerrima* and in *Microspora tenerrima*, with the exception that, in the latter case, no gelification was observed of the outer layers of the cell-wall.

In *Stigeoclonium* the cysts are formed by the contraction of the contents of the mother-cell, which then divide into two or four spores, or, in the

* Proc. Linn. Soc. N. S. Wales, i. (1886) p. 476.

† Bull. Soc. Bot. France, viii. (1886) Sess. Extraord., pp. li.–lx.

case of *S. tenue*, without any such division. In *Draparnaldia glomerata β biformis*, and in *Chætophora tuberculosa*, the cysts are formed either in the ordinary way within the cell, or the contents escape and clothe themselves with a new cell-wall outside the mother-cell; in the former species the cysts produced in this way form moniliform rows of cells attached to the thallus.

The cysts may either remain green during their period of dormancy, or may become deeply coloured by an orange pigment; the former is the case especially where desiccation has not been complete.

Tannin in Algæ.*—M. E. De Wildeman has investigated the occurrence of tannin in fresh-water algæ. All the algæ examined, except the Nostocaceæ and Batrachospermeæ, whether floating on the surface of the water or fixed to the bottom or terrestrial, whether affecting marshes or calcareous waters, were found to contain larger or smaller quantities. M. Wildeman regards the tannin as not a mere product of excretion, but as performing an active function in assisting assimilation. The best test for its presence, at least in algæ, is the reaction with salts of iron.

Morphology of Polysiphonia.†—M. K. Rosenvinge describes the mode of formation of the tetraspores, antheridia, and cystocarps, in several species of *Polysiphonia*. The two latter organs he regards as leaves or modified parts of leaves. The mode of branching and leaf-divergence are also described. In *P. fastigiata* peculiar annular formations occupy the intercellular spaces between the central cell and the pericentral cell.

Epiclemmydia lusitanica, a new species of Alga.‡—Mr. M. C. Potter has investigated the life-history of a new species of alga, now named *Epiclemmydia lusitanica*, which lives on the backs of the tortoises inhabiting the pools of Southern Europe. This alga, which to the naked eye appears as small green roundish patches, is found to consist of a number of cells closely applied to the tortoise-shell, but which are only a few layers deep, here and there penetrating into the shell and causing it to flake off. The cells next to the shell always force their way into any available crack, where they divide, and thus penetrate to some depth. The alga is reproduced by means of zoospores formed in the external layer of cells. These zoospores are all exactly similar, and swim about for a considerable time, after which they come to rest, and germinate.

Arctic Algæ.§—Prof. W. G. Farlow publishes a descriptive list of Arctic algæ, collected chiefly in Ungava Bay. It is distinguished by the large number of Florideæ, rare in Arctic latitudes. Among the material collected by L. Kumlien he describes twenty-two species of Florideæ, thirteen of Phæosporeæ, and five of Chlorosporeæ.

Phycotheca Italiana.—The first fascicle of this publication by Signori G. B. Toni and D. Levi has appeared, comprising fifty species of algæ, marine and fresh-water, all from the Venetian territory.

Scandinavian Algæ.‖—M. G. Lagerheim describes seventy interesting species or varieties of algæ gathered in Sweden, including eighteen new species, chiefly desmids and Cyanophyceæ. Among the species described and figured is a new *Oocystis*, *O. submarina*.

* CR. Soc. R. Bot. Belg., 1886, pp. 132-43. Cf. this Journal, 1884, p. 832.
† Bot. Tidsskr., xiv. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 149.
‡ Proc. Cambridge Phil. Soc., Nov. 8, 1886. See Nature, xxxv. (1887) p. 214.
§ Proc. Amer. Acad. Arts and Sci., 1886, pp. 469–77.
‖ Bot. Notiser, 1886, pp. 44–50. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 158.

American Desmids.*—M. G. Lagerheim states the number of species of Desmidieæ at present known in the New World at about 600; the American flora is distinguished by the large number of species of *Pleurotænium* and *Arthrodesmus*, and by one genus, *Phymatodocis*, not yet found in Europe. Many of the American desmids belonging to the genera *Cosmarium*, *Arthrodesmus*, and *Xanthidium*, have remarkable thickened membranes, more or less yellow, and pitted along the median furrow.

Pyritized Diatoms.†—Dr. A. A. Julien states, with regard to "pyritized diatoms," that the material referred to by all writers under the broad name of pyrites, consists substantially of the single mineral pyrite. To determine this point, he searched for minute cavities in which the substance might have found opportunity to crystallize, and discovered not only minute drusy surfaces, but also little spherules covered by projecting crystals. The globules which Mr. Kitton detected appear to have been round and smooth, probably concretionary. On those which he discovered may be seen triangular faces, which appear to belong to octohedra; these crystals must therefore consist of pyrite. This conclusion is confirmed by a specimen of fossil fruit converted into pyrites from the London clay at the Isle of Sheppey. This drusy surface shows distinct sharp octohedra of larger size, so that this crystalline form probably prevails in the pyrite crystals throughout the London clay. The true colour of the pyrite films, when examined on a fresh cross fracture, appears to be a greyish-white. This indicates that the crystals are far from pure, probably mixed with a large proportion of marcasite. The incipient decomposition of the mineral is characteristic of the presence of marcasite, beginning with a golden-yellow tarnish within, and assuming a bronze colour without. As the decay progresses, the valves become covered by a reddish film of iron oxide, and finally the entire material passes into reddish-brown iron-ochre, sometimes blackened as if by the intermixture of oxide of manganese. The mode of deep subterranean decomposition is, therefore, hepatic, and vitriolescence is never observed in these altered diatoms; although the latter form of decay attacks the nodules of pyrites lying nearer the surface in the London clay, at other points along the Thames, as at the Isle of Sheppey.

Lichenes.

Receptacles for reserve-materials in Lichens.‡—Herr H. Zukal finds in the hyphal system of some lichens, especially on the under side, rows or clusters of swollen spheroidal cells which may attain a diameter of 15 μ. They are most abundant in species of *Verrucaria*, but are by no means invariably present in them, and occur also in other genera. By the application of micro-chemical tests, they were found to contain a fatty oil, and the author suggests that they serve as reservoirs of food-material for the formation of fructification.

Fungi.

Endogenous Production of Spores.§—Pursuing his investigations on the mode of production of the spores of fungi, M. J. de Seynes states that a considerable number which are usually described as exogenous are in

* Oefver. K. Vetensk. Akad. Förh. Stockholm, 1885, pp. 225–55. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 159.

† Journ. New York Micr. Soc., ii. (1886) pp. 85–96.

‡ Bot. Ztg., xliv. (1886) pp. 761–70 (2 figs.).

§ De Seynes, J., 'De la production des corps reproducteurs appelés acrospores,' 51 pp. and 3 pls., Paris, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 145. Cf. this Journal, 1886, p. 832.

reality complex bodies resulting from a union of the wall of the spore with the wall of the mother-cell; and this may probably be the case with the Basidiomycetes. In *Peziza cupressina* the ascospores are formed in this way, and not by free-cell-formation; the ascus with its spores forms a necklace-like kind of structure which ultimately breaks up into joints. The same is the case with the chlamydospores of the Mucorini and in *Mycoderma vini*. The two types of spore, free and united in growth to the wall of the mother-cell, may even be found in the same individual; as in *Sporochisma paradoxum*, the former in the lower, the latter in the upper part of a filament.

In *Ptychogaster albus* and *Polyporus sulfureus* we find terminal spores which are apparently acrogenous, but really endogenous; while those of the sporangioles of *Chætocladium* and *Piptocephalis* are truly endogenous. In the formation of the conidia of *Aspergillus candidus* the protoplasm may be seen to accumulate at several points of the filament, and each spore clothes itself with a membrane intimately fused with that of the mother-cell; the spores finally presenting the appearance of a necklace. The same is the case in *Penicillium glaucum*. In *Psilonia cuneiformis* the spores are of endogenous origin, and the filament continues to grow after they have fallen to the ground.

Formation of Starch in Sclerotia.*—M. E. Belzung has investigated the mode of formation of the starch in the sclerotia of *Claviceps purpurea* and *Coprinus stercorarius*, and finds that it is different from that which takes place in the endosperm of the castor-oil plant, where there is no fresh formation of leucites during germination, the starch being produced entirely in the pre-existing leucites. Fungi, on the contrary, are capable of producing true starch-grains. In the sclerotia named, the cell-contents consist entirely of leucites in the form of a very fine granulation; and it is in these leucites that the abundant starch is formed.

Helicobasidium and Exobasidium.†—From further examination of the mature fructification of *Helicobasidium purpureum*, parasitic on *Asarum europæum*, M. N. Patouillard maintains his view that the genus must be kept distinct from *Exobasidium*. He also dissents from the proposal to place its species as a subgenus of *Corticium*.

Conidial Form of Hymenomycetes.‡—M. N. Patouillard describes a new fungus to which he gives the name *Ptychogaster aurantiacus*, the inner portion of which is composed of hyphæ mingled with large spores, 12–14 μ by 5–6 μ, the medium portion having, on the contrary, spores formed at the extremities of the filaments. The spores are formed by the filament swelling at its apex, where the protoplasm accumulates, and becomes separated by a septum. It is probably the conidial state of a Polyporea allied to *Trametes*.

Macrophoma, a new genus of Sphæropsideæ.§ — Under the name *Macrophoma* Berl. and Vogl, Sig. A. N. Berlese proposes a new genus containing no fewer than 99 species removed from the genera *Phoma*, *Sphæropsis*, and *Sphæronema*. The following are its characters:—Perithecia subcutanea, dein erumpentia membranacea subcoriacea et subcarbonacea globosa glabra erostrata, ostiolo minuto subinde obsoleto. Sporulæ ovoideæ fusoideæ v. cylindraceæ majusculæ v. magnæ, 15 amplius μ longæ sæpe granulosæ continuæ hyalinæ, rarissime biguttatæ. Basidia filiformia subinde brevissima v. obsoleta, constanter simplicia.

* Bull. Soc. Bot. France, viii. (1886) pp. 198–202.
† Ibid., pp. 335–7. Cf. this Journal, 1885, p. 1045.
‡ Rev. Mycol., 1885, p. 28 (3 figs.).
§ Atti Soc. Ven.-Trent. Sci. Nat., x. (1886) pp. 176–205 (2 pls.).

Conjugation of Mucorini.* — M. P. Vuillemin describes a peculiar mode of conjugation, or, as he prefers to term it, anastomosis, in a hitherto undescribed species of *Mucor*, which he calls *M. heterogamus*. This process, which results in the production of the zygospore, consists, in this species, of the union of two very unequal elements proceeding from branches as dissimilar as possible. The first stage is the appearance of a transverse septum near the apex of the principal filament or of one of its branches. The apical segment thus formed increases rapidly in length, but remains slender, and contains a comparatively small amount of protoplasm. Below it the protoplasm accumulates, and forms a lateral bud. The extremity of this protuberance swells and curves, while opposite to this swelling the slender filament puts out a lateral emergence. These two gametes, very unequal in size, conjugate, and each becomes separated from its parent filament by a septum; the membrane which divides them disappears, as also does the beak which constitutes the smaller gamete.

The zygospore thus formed, has, when mature, a thin internal membrane furnished with simple points, and an external brown coat with black almost confluent plates. Instead of the single lateral swelling, there are sometimes two, which conjugate with the small protuberances from the single slender filament.

Membrane of the Zygospores of Mucorini.†—M. P. Vuillemin has traced the history of development of the wall of the zygospores in *Mucor heterogamus* (*vide supra*), and in some other species of Mucorini. He does not admit two distinct membranes of different origin, as in the oosphere of Peronosporeæ, but only one, with centripetal growth, which becomes ultimately differentiated into five distinct zones. While admitting that these two organs are possibly of similar origin, he regards the zygospore of the Mucorini as probably not of a sexual nature, but as an asexual spore preceded in its formation by the simple anastomosing of vegetative branches.

Development of Pyrenomycetes.‡—Herr F. von Tavel has followed the history of development of some of the numerous kinds of parasitic fungi found on plane-leaves.

Of *Glœosporium nervisequum* Sacc., which is very destructive to young trees, he was unable to discover either the perithecia or pycnidia; from the gonidia was developed only a similar conidial form.

Discula Platani Sacc. must be regarded, from its history of development, as a pycnidium, although differing in some points from the usual structure. Its further development, however, the author was unable to follow. Leaves of the plane-tree were infected by it without result. It is always found in close proximity to the *Glœosporium*, and may possibly be a stage in its cycle of development.

Growing out from a *Cytispora* was a new form, which v. Tavel describes as *Fenestella Platani*. The basidia are unbranched, and produce enormous numbers of unicellular spores. The asci contain eight spores, which are septated, when mature, by three septa. Agreeing in general characters with the genus *Fenestella*, it differs from the species hitherto known in the small number of septa to the spores, and in the unusual development of the neck. From its ascopores is developed a conidiiferous mycelium belonging to the form *Acrostalagmus*. A genetic connection between this and the pycnidial form, though probable, the author was unable actually to determine.

* Bull. Soc. Bot. France, viii. (1886) pp. 236–8. † Ibid., pp. 330–4.
‡ Bot. Ztg., xliv. (1886) pp. 825–33, 841–6, 857–67, 873–8 (1 pl.).

A species of *Cucurbitaria*, which is probably new (*C. Platani?*), was also observed. It appears to be a saprophyte rather than a parasite. Both pycnidia and ascospores were observed.

Protoventuria, a new genus of Pyrenomycetes.*—From the well-known genus *Venturia* De Not., Sig. A. N. Berlese proposes to separate *V. Rosæ* as a distinct genus under the name *Protoventuria* Berl. et Sacc., with the following diagnosis:—Perithecia superficialia majuscula carbonacea fragilia globosa-depressa, vertice setis rigidis aterrimis longiusculis vestita, basi setulis subtilioribus numerosissimis pallidis subtortuosis septatis cincta, poro rotundo amplo pertusa. Asci oblongi v. elliptici, basi abrupte attenuati, in pedunculum brevissimum desinentes, octospori. Paraphyses nullæ v. obsoletæ. Sporidia constricto-didyma bilocularia, loculis subæqualibus saturate fuligineis.

New genera of Pyrenomycetes.†—M. N. Patouillard describes the two following new genera of Pyrenomycetes, both from China.

Cylindrina. Perithecia simple, somewhat horny, erect, cylindrical, truncate, and hollowed at the summit into a cup, in the centre of which is a pore. Thecæ cylindrical, greatly elongated. Spores filiform, continuous. Paraphyses slender, simple, very numerous. Near to *Acrospermum*. *C. Delavayi* was found on dead leaves of *Liparis liliiflora*.

Pyrenotheca. Stroma bearing a large number of close rounded black carbonaceous receptacles, formed of a homogeneous cellular tissue, hollowed in its upper part by a large number of pits arranged irregularly in several rows, and each inclosing a single globular or ovoid sessile theca containing eight colourless ovoid septated muriform spores. Paraphyses 0. Near to *Eurytheca*. *P. yunnanensis*, parasitic on the living bark of a *Buxus*.

Tubercularia.‡—Dr. F. Morini discusses the systematic position of this genus of Fungi, and dissents from the conclusion of Gobi that it belongs to the Ustilagineæ. He regards the mode of sporification as differing essentially from that in *Entyloma*, in the distinct differentiation of a mycelium and fertile hymenium, which does not exist in that genus. The cycle of development of *Tubercularia* is also altogether different from that which occurs in the Ustilagineæ. As regards its true position, Morini thinks that *Tubercularia* shows the greatest affinity with the Tremellini.

Contrary to the view of de Bary, Morini regards the process of anastomosis displayed by the sporidia of many Ustilagineæ as a phenomenon of simple fusion of cells, and as having no sexual character.

Scandinavian Peronosporeæ, Ustilagineæ, and Uredineæ.§—In a detailed account of these parasitic fungi from the lofty mountains of Jämtland and Härjedalen, Herr C. J. Johanson remarks on the comparative abundance of the subgenera *Leptopuccinia* and *Micropuccinia*, distinguished by the absence of the uredo- and æcidial forms. While in Germany the species of these subgenera make up 33 per cent. of the entire genus *Puccinia*, in Italy 30 per cent., and in Holland 25 per cent., in the districts above referred to they amount to 60 per cent. The following new species are described:—*Peronospora alpina* on *Thalictrum alpinum*, *Puccinia rhytismoides* on the same plant; *P.* (*Micropuccinia*) *rubefaciens* on *Galium boreale*, *P.* (*M.*) *scandica* on *Epilobium anagallidifolium*.

* Atti Soc. Ven.-Trent. Sci. Nat., x. (1886) pp. 171–5 (1 pl.).
† Bull. Soc. Bot. France, viii. (1886) pp. 155–6.
‡ Malpighia, i. (1886) pp. 114–24.
§ SB. Naturvet. Studentsällsk. Upsala, Oct. 12, 1886. See Bot. Centralbl., xxviii. (1886) pp. 347 *et seq.*

Ancylisteæ and Chytridiaceæ.*—Dr. W. Zopf describes in detail the structure and life-history of the following fungi parasitic on various species of *Zygnema*, *Mougeotia*, *Spirogyra*, *Cladophora*, diatoms, *Saprolegnia*, and other fresh-water organisms, viz.:—*Lagenidium Rabenhorstii*, *L. entophyllum*, *Myzocytium proliferum*, *M. proliferum* var. *vermiculum* (on nematoid worms), *Olpidiopsis Schenkiana*, *Pleotrachelus fulgens*, *Ectrogella Bacillariacearum*, *Amœbochytrium rhizidioides*, *Hyphocytium infestans* (on a *Peziza*), *Rhizidiomyces apophysatus*, *Rhizidium intestinum* (on *Nitella*), *R. bulligerum*, *R. Cienkowskianum*, *R. Fusus*, *R. carpophilum*, *R. sphærocarpum*, *R. appendiculatum* (on a Palmellacea), *R. apiculatum*, and *R. acuforme*.

Dr. Zopf adopts Pfitzer's classification of the genera *Ancylistes*, *Lagenidium*, and *Myzocytium* into a distinct family under the name Ancylisteæ, distinguished from the rest of the Saprolegniaceæ by the circumstance that the existence of the vegetative organ as such closes with the development of the fructification, the mycelial tube being entirely used up in the formation of the sporangia or of the sexual organs; while in the higher Oosporeæ the mycelium may even continue to develope after the formation of the fructification. The mycelium is in this group always very feebly developed, and in *Myzocytium* is almost entirely suppressed; while in the higher Saprolegniaceæ and Peronosporeæ it attains to the dignity of a copiously branched mycelial system.

A third characteristic of the group is in the mode of formation and escape of the swarmspores, at present known only in *Ancylistes*, and agreeing more with *Pythium* than with *Saprolegnia*. The zoospores are perfectly formed only outside the sporangium, in the vesicle formed by the tumidity of its inner cell-wall. A further distinction from both Saprolegniaceæ and Peronosporeæ consists in the process of impregnation. While in both these groups the oosphere is completely formed before impregnation, in the three genera under discussion this takes place only during and subsequently to that process; and, instead of only a portion of the contents of the antheridium being required for the purpose of impregnation, the whole passes over into the oogonium. Again, while in the Peronosporeæ only a portion, in these genera the whole of the protoplasm of the oogonium is used up in the formation of the oosphere.

These peculiarities of structure are held by Dr. Zopf sufficient to justify the formation of a separate group of Ancylisteæ out of three genera, although the process of impregnation has not yet been observed in *Lagenidium*, and only imperfectly in *Myzocytium*. But the process, as known in *Ancylistes*, forbids the idea of a very close affinity between this group and the Pythieæ; it much more nearly resembles a process of true conjugation than in that family.

While the Ancylisteæ exhibit an affinity upwards with the higher Oosporeæ, they are also connected downwards with the Chytridiaceæ, and especially with certain Olpidieæ. This is well seen in the resemblance between the reduced neutral and sexual individuals of *Myzocytium proliferum* on the one hand, and between the neutral and sexual individuals of *Olpidiopsis Schenkiana* on the other hand. This resemblance is so great, that unicellular sporangial plants of the former species cannot be distinguished from sporangia of the latter, when both are still unripe or already discharged. There is a similar close resemblance between the mycelial tube of *Ectrogella* and that of *Ancylistes*.

On these grounds the author suggests that the Olpidieæ are possibly

* Verhandl. K. Leop. Carol. Deutsch. Akad. Naturforscher, xlvii. (1885) pp. 141–236 (10 pls.).

reduced Ancylisteæ, the reduction being displayed in the disappearance of the antheridial fertilizing tube on the one hand, and in the reduction, on the other hand, of the oogonium to an oosphere, as seen in *Olpidiopsis Schenkiana*. In other Olpidieæ the reduction may be carried out still further to apogamy, or the entire suppression of the antheridia, as possibly in *O. Saprolegniæ*.

Fungi parasitic on Coniferæ.*—Dr. E. Rostrup describes a number of fungi parasitic on different species of conifers in various parts of Denmark.

In one district a peculiar disease was noticed on *Pinus excelsa*, due to the attacks of *Nectria cucurbitula* on the lower part of the stem; the blood-red sporangia forming a perfect ring round the stem.

Pinus balsamea was in many places attacked by *Thelephora laciniata*, forming great balls.

In one district various species of pine (but not *P. austriaca*) were badly attacked by *Cæoma pinitorquum*. This had been communicated from an aspen on which *Melampsora pinitorquum* was strongly developed.

The author was able to determine, by direct observation, that *Lophodermium Pinastri* is the cause of the disease of *Pinus austriaca*. The ends of the branches lose their colour from the attacks of the mycelium, which then penetrates into the leaves, and ramifies through the whole tree.

New Genus of Chytridineæ.†—M. P. A. Dangeard has observed a parasite endogenous in several Rhizopods and Flagellata, which he regards as the type of a new genus of Chytridineæ, and calls *Sphærita endogena*. It first makes its appearance in the form of single vesicles of hyaline protoplasm within the body of the host, a portion of the surface being finely granular. Gradually the protoplasm becomes denser and finely punctated, and finally breaks up into a number of zoospores with a mulberry-like appearance.

The author considers that the theory of the reproduction of the Flagellata by division of the nucleus, first advanced by Stein, and adopted by Carter and Saville-Kent, rests on an erroneous interpretation of the appearance presented by the germs of parasitic Chytridineæ; and that the so-called endogenous germs described in a large number of species of Eugleneæ may all be referred to *Sphærita endogena*.

In a second paper‡ M. Dangeard describes a new species of *Chytridium*, *C. helioformis*, parasitic on a *Nitella*, and which he succeeded in cultivating also on *Chara polyacantha* and on a *Vaucheria*. The cysts of this species develope like sporangia, and there is no trace of any sexual reproduction. Cienkowski's *Rhizidium Confervæ-glomeratæ* is regarded by Dangeard as a *Chytridium*.

Structure of Entyloma.§—Prof. H. Marshall Ward has investigated the structure and life-history of *Entyloma Ranunculi*, a parasitic fungus belonging to the Ustilagineæ, found on *Ranunculus Ficaria*. He found the resting-spores and conidia on the same mycelium. The process of germination of the spores was followed out, which had not previously been done in the case of any *Entyloma*. The germinal hyphæ enter the stomata of the host, and produce between the cells of the mesophyll a mycelium on which are borne the resting-spores, thus placing beyond doubt the connection between the two kinds of spore.

* In Danish, 1885. See Bot. Centralbl., xxviii. (1886) p. 105.
† Bull. Soc. Bot. France, viii. (1886) pp. 240–2. ‡ Ibid., pp. 357–8.
§ Proc. Roy. Soc. Lond., xli. (1886) p. 318.

New Synchytrium.*—The *Synchytrium*, parasitic on *Dryas octopetala*, and previously considered by Dr. F. Thomas as a variety of *S. Myosotidis*, he now describes as a distinct species under the name *S.* (*Chrysochytrium*) *cuspidatum*. It is distinguished by the form of the cecidium induced in the host by the parasite, which extends above the epidermis, is at first globular or the form of an elongated sac, and afterwards closes into that of a cup or saucer. It is identical with the variety *Potentillæ* Schœt.

Alcoholic Fermentation on living Trees.†—Dr. F. Ludwig has observed on living oak-trees, as well as less frequently on birches, poplars, and maples, the formation, sometimes in large quantities, of a whitish mucilage with a strong odour of beer, and having great attraction to a number of insects, especially hornets. The fungoid masses which give rise to this mucilage consist of a branching filamentous fungus, forms allied to *Saccharomyces*, and an organism evidently allied to *Leuconostoc*.

The alcoholic fermentation is caused by the filamentous fungus, which clearly belongs to the Gymnoasci, forming the characteristic endospores, and proposed by the author as a new species with the name *Endomyces Ludwigii*. The main filament branches copiously, and both it and the branches break up freely into gonidia, which vary greatly in size. The formation of asci was frequently observed. These are obovate, 25–30 μ long, 18–20 μ broad, and are formed at the end of longer or shorter main or secondary branches. The ascospores are always four in number, and change in colour from pale yellow to yellow-brown; they are set free by the absorption of the ascus. The alcoholic fermentation appears to be caused directly by the formation of the branches of this fungus, although it is then greatly promoted by the formation of the bacteria found in the mucilage. The development of the conidia corresponds very closely to that of *Saccharomyces albicans*.

The mucilage consists mainly of a Schizomycete, to which Dr. Ludwig gives the name *Leuconostoc Lagerheimii*, which forms elongated or spherical colonies, often of very large size, consisting of wavy or coiled chains of cocci or diplococci enclosed in copious gelatin; the cocci have a diameter of about 0·6–0·8 μ. The gelatinous envelope is of much less consistency than that of *L. mesenteroides*. Small spherical colonies of this organism appear to be formed first on the filaments of the *Endomyces*, the cell-walls of which they then completely destroy. Placed on meat-peptone nutrient gelatin, they cause it rapidly to deliquesce.

Protophyta.

Hormogones of Glœotrichia natans Thur.‡—Dr. G. Beck records in this species (*Rivularia angulosa* Roth.) a peculiar mode of formation of hormogones. The lowermost cell becomes a heterocyst, and its contents pass through a pore or through an open communication into the next cell, which becomes the basal cell of a hormogone. The hormogones produced in this way differ from those formed in the ordinary manner in possessing a heterocyst from the first.

Reproduction of Codiolum.§—M. G. Lagerheim confirms the statement of Farlow with respect to another marine species of *Codiolum*, that *C. polyrhizum* is not reproduced by zoospores, but by rounded immotile aplanospores, inclosed in a delicate membrane. These develope directly

* Bot. Centralbl., xxix. (1887) pp. 19-22. † Hedwigia, xxv. (1886) pp. 168-72.
‡ Verhandl. K. K. Zool.-Bot. Gesell. Wien, xxxvi. (1886) pp. 47-8.
§ Oefvers. K. Vetensk. Akad. Förh. Stockholm, 1885, pp. 21-31. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 158.

into the adult cell, which attains a height of from 90–170 μ. *C. polyrhizum* is found on empty marine shells, which also serve to support *Mastigocoleus testarum*.*

Urococcus, Coccochloris, and Polycystis.†—Herr P. Richter describes the life-history of *Urococcus insignis*. In its early stage it has all the appearance of a *Glœocystis*, but is not identical with any known species. The well-known "stalk" is not peculiar to the genus, but belongs also to *Glœocystis* and *Hormotila*. When actively growing *H. insignis* has no stalk, and is then simply inclosed in a larger or smaller number of excentric envelopes, and closely resembles *Chroococcus macrococcus*, with which it may be identical.

The author proposes to restore the old genus *Coccochloris*, which has been merged in *Aphanothece*, and describes *C. stagnina* Spreng., with which he unites *Aphanothece cærulescens* Br.

A remarkable new species, *Polycystis scripta*, is described, forming a sulphur-yellow scum on the surface of salt water; it appears to derive its sustenance from decaying seaweeds.

Pathogenic Bacteria.‡—Herr H. Mittenzweig summarizes the work of German investigators on pathogenic bacteria. He adopts the classification of Koch and Hüppe, founded on their form. After describing the various processes of studying bacteria, he details the observations of German bacteriologists on certain special microbes, such as those of cholera, typhoid fever, gonorrhœa, syphilis, &c., the various properties of these bacteria being described in detail.

Tuberculosis of the Olive.§—M. L. Savastano has investigated the diseases of the olive somewhat indiscriminately known as "maladie de la loupe" and "rogna"; some being caused by hypertrophy of the tissues due to external causes, others by a special bacterium which forms tubercles on the young branches. This bacterium, named by Arcangeli *Bacterium oleæ*, was cultivated on potato and gelatin, but no exact description is given of it.

Tubercle Bacilli‖—As the result of prolonged investigations, Herr v. Sehrön notes:—(1) the tubercle bacillus is in its young stage a torula-chain; (2) with increased growth the granular elements of the chain become distant, and are united by a band; (3) the intercellular substance of the *Bacillus* is a secretion of these elements, and is formed by apposition; (4) in retrogressive metamorphosis the granules of the torula-chain become free as bacillar spores; (5) these liberated spores grow into mother-spores, which exhibit a capsule and enclosed contents; (6) the finely granular contents of the mother-spores become daughter-spores; (7) the daughter-spores burst the capsules and issue singly or in a torula-chain (young *Bacillus*) from the mother-spore.

* See this Journal, 1886, p. 665. † Hedwigia, xxv. (1886) pp. 249–55.

‡ Mittenzweig, H., 'Bacterien-Aetiologie der Infections-Krankheiten,' 136 pp., Berlin, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 177.

§ Comptes Rendus, ciii. (1886) pp. 1144–7.

‖ Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, Berlin, 1886. Cf. Biol. Centralbl., vi. (1886) p. 634.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Grunow's Physician's Microscope.†—In this instrument, designed by Mr. J. Grunow (figs. 35 and 36), the whole stand is of brass, with

Fig. 35.

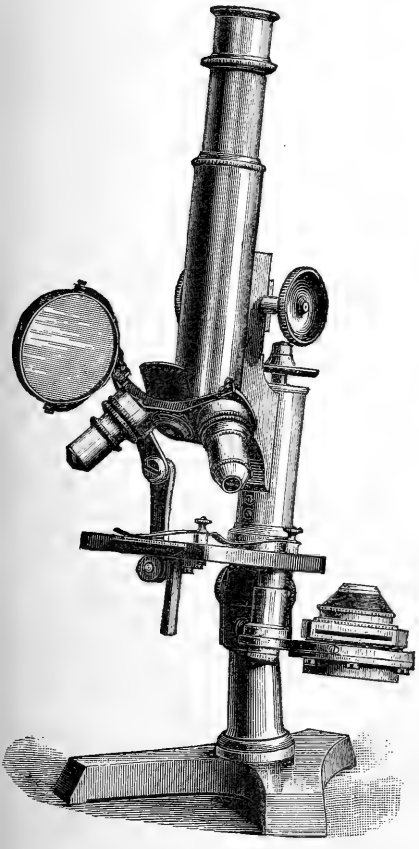
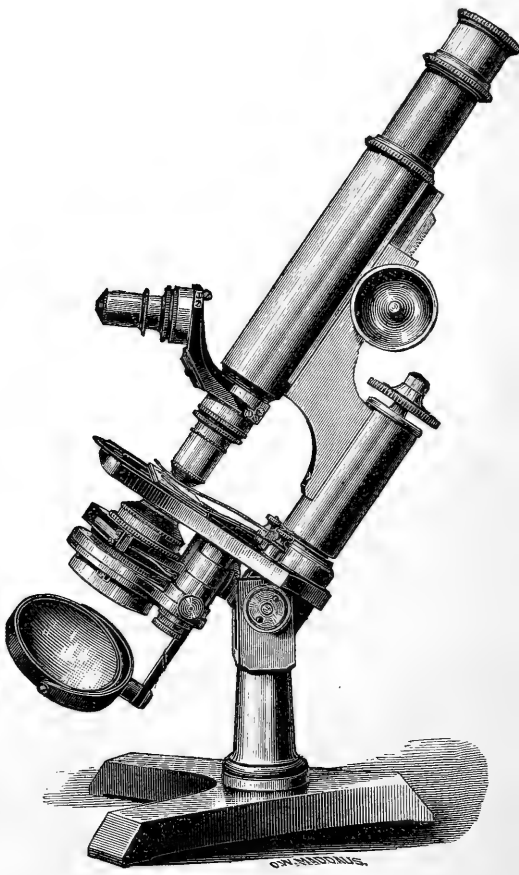


Fig. 36.



rack-and-pinion coarse, and micrometer-screw fine-adjustments. The stand can be inclined to any angle. The mirror is mounted on a double arm, so that it can be swung above the stage for the illumination of opaque objects. The substage is on a pillar attached to the base of the Microscope, and may be turned aside, thus facilitating the exchange of accessories without disturbing the object in the field.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating Apparatus; (4) Other Accessories; (5) Photo-micrography; (6) Microscopical Optics and Manipulation; (7) Miscellaneous.

† The Microscope, vi. (1886) p. 245 (1 fig.).

Burch's Perspective Microscope.*—Mr. G. J. Burch, in 1874, while trying to devise means whereby the different planes of an object should be visible under the Microscope without the adjustment of the focus to each, discovered that, when two lenses are separated by a distance equal to the sum of their focal lengths, the optical conditions are such that the magnitude of the image bears a constant ratio to that of the object, no matter where upon the optic axis it is situated—the ratio being that of the focal lengths of the two lenses; that a given displacement of the object along the axis causes a displacement of the image in the same direction, but in the square of the ratio.

Further, that a picture drawn with the camera lucida under these conditions has the perspective of an object magnified in the square of the ratio, when it is brought within the proper distance of the eye.

The field of view of the perspective Microscope is small, but may be increased by using more than two lenses, and the author's researches gave him reason to believe that, with glasses of wide angle specially constructed, a high power, with sufficiently large field, might be obtained. Several uses other than microscopic were indicated, to which the instrument can be applied.

The paper, as read to the Royal Society, was accompanied by diagrams, showing, in two different ways, the changes of position of the principal foci and principal points, &c., of a system of two lenses, as the distance between them is varied, and a piece of moss was shown under the instrument, in magnified perspective.

Entomological Microscope.†—M. J. L. Weyers discusses the proper form, &c., of a Microscope suitable for entomologists, which we read with attention until nearly its conclusion, without clearly appreciating what the author proposed in the way of an improvement upon the existing forms. The last paragraph, however, dispensed with any necessity for again reading the paper to supply the missing clue. That paragraph runs as follows:—"In fine, the compound entomological Microscope requires no novel arrangement; no unknown accessory. It simply aims at uniting in one and the same instrument the different arrangements applied hitherto separately to the usual compound Microscopes."

Lehmann's Crystallization Microscopes.‡—Dr. O. Lehmann has now found it possible to construct a smaller, more portable, and cheaper form of the Microscope, with which his observations on the growth of crystals were made.§

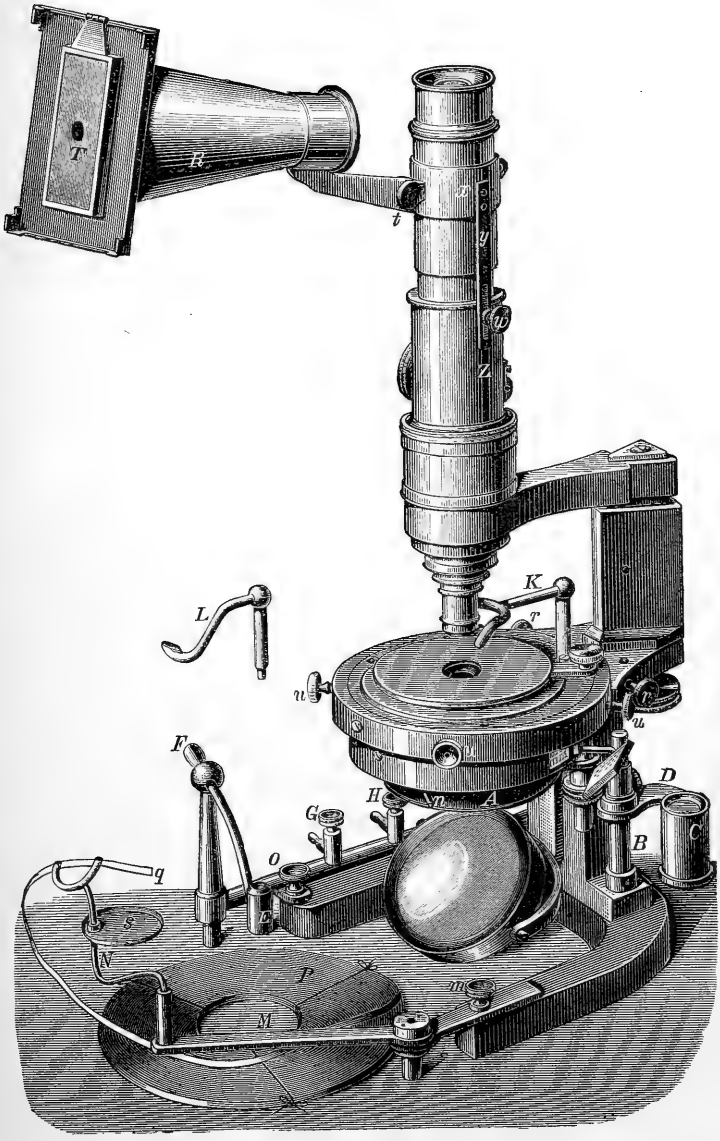
The new instrument, as described by him under the name of the "*Small Crystallization Microscope*," is shown in fig. 37, from which it will be seen that it is not so much a Microscope of special construction (in fact it is a Merz 1866 instrument) as an ordinary instrument adapted by the addition of certain supplementary parts.

The form of the stage is shown in fig. 38; the hollow rotating centre *b* carries the platinum covered stage *a* supported on a cylindrical ring which is pierced with numerous holes to allow the products of combustion to escape as indicated by the arrows, while to its lower side is fixed the graduated circle *c*; *d* is a handle by which the stage is turned, and which abuts against a stop for the zero point of the scale; the tube *e* in which the stage rotates is centered by the four screws *u*; the index is fixed to this

* Nature, xxxv. (1887) p. 358.
† Comptes Rendus Soc. Entomol. Belg., 1886, pp. xc.–iii.
‡ Zeitschr. f. Instrumentenk., vi. (1886) pp. 325–34 (3 figs.).
§ See this Journal, 1885, p. 117.

piece so that it is not disturbed by the centering of the stage, and at *f* is a small aperture through which the observer reads the scale from a vertical position by means of the inclined mirror shown in fig. 37. The rotation of the upper part of the Microscope is confined within very narrow limits by

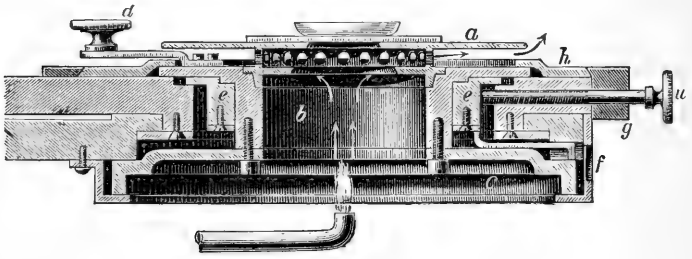
FIG. 37.



the two screws *r r* of fig. 37, and is only employed to bring the index and zero point of the scale into coincidence after centering. The cover *h* and circular band *g* serve as protections for this part of the instrument.

A (fig. 37) is the frame of a diaphragm of the ordinary form, except that the smallest opening has been replaced by a large one, which can be partially closed with a crescent-shaped screen by means of the handle *n*. C is the polarizer attached to the arm D, which slides on and revolves round the column B, so that it can be rapidly introduced and withdrawn while the object is being heated. The heating apparatus consists of the

FIG. 38.

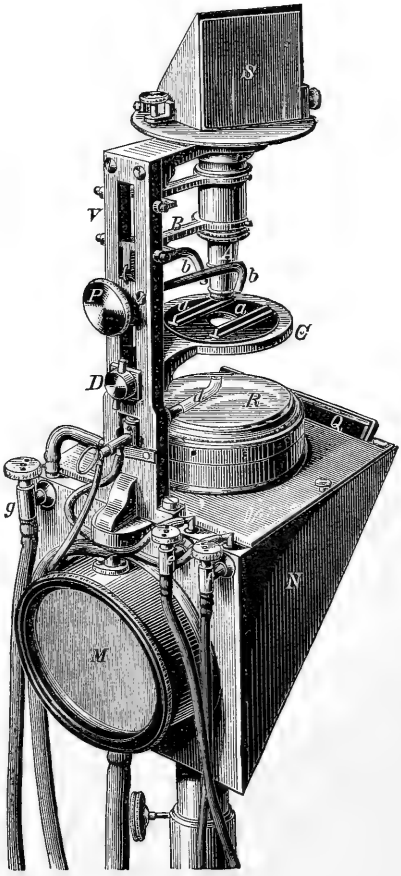


burner E which is supplied with gas and air through the taps G and H; it is fixed to a movable arm, and is adjusted by the handle F, and clamped by two screws, of which one is seen at O; the tube which conveys air is continued inside the gas-tube until it almost reaches the beginning of the arm; the burner is closed at the bottom by a plate of mica, so that the object may be partly illuminated from below through the flame. K is a tube with double orifice which is used for cooling the object by means of a current of air transmitted through a passage in the foot of the instrument and regulated by a screw tap, so that the temperature is completely under control, and may be varied at will. M is a movable arm with stop, which is attached by the screw *m* to the other foot of the instrument and carries a holder N; this serves to support the end of a magnesium band P over the tray *s*, and it is pivoted so that the projecting portion of the band at *q* may be directed towards the mirror; in this way the field remains brilliantly illuminated as the metal burns; the same burner E which is used for heating purposes may be also employed to ignite the wire. The magnesium flame is used for photographing the object, and for this purpose the upper part of the tube Z is provided with a movable ring *x*, to which is attached by the hinge *t* the camera R. The Microscope may then be rapidly converted into a photographic apparatus by swinging R into the vertical position. T is a hinged frame carrying a ground-glass plate by which the image is roughly focused, the final adjustment being made upon a small spot of smooth glass which occupies the centre of the ground-glass plate by means of a lens hinged to T; the camera is clamped in position by the screw *w* which passes through a slot in the bar *y* firmly attached to *x*, and finally the focusing plate is replaced by an aluminium slide containing the sensitive dry plate. The dry plates used are of small size (6·5 × 9 cm.), and may be developed and fixed by the light of a petroleum or gas lamp with red chimney.

In place of K the tube L (shown at the side of the figure) may be mounted on the stage; this tube is used to direct a current of air upon the objective, so as to protect the lenses against the heat of the stage and to carry away the products of combustion which would otherwise condense upon them; if a greater degree of cold is required, this current of air may be first passed through a freezing mixture and drying tube.

The chief object which this instrument seeks to attain is the rapid change of certain parts; the heating apparatus, the magnesium-light, the camera, the cooling apparatus, and the polarizer, are all so constructed that they may be introduced and withdrawn without loss of time, since the operations have to be conducted with great rapidity during the growth of the crystals. The author suggests other additions and improvements which might be made; for instance, a water cooling-apparatus for fusion experiments; a roll of sensitive paper to be used for a continuous series of photographs in place of a set of dry plates, &c., and promises an account of observations which he has recently made with the Microscope upon bodies under high pressures, in small capillaries, and in vacuum.

Fig. 39.



The *Crystallization Microscope for projection* is shown in fig. 39. A is the objective which is adjusted by a parallelogram movement B by means of the screw P. The stage C is movable along a vertical slot in the upright V, and is clamped by the screw D. The object lies upon the two edges *a*, which allow a free passage of the air, and *b b* are as before the two tubes by which the object is cooled; *d* is a glass burner which receives its supply of gas and air through the two screw-taps *e* and *f*; the current of air in *b* being regulated by the screw-tap *g*.

The light from an electric lamp enters the apparatus at M through two parallel plates of glass through which circulates a current of water free from lime, such as rain-water; ordinary water soon leaves a deposit of carbonate of lime upon the glass, and cannot be used for the purpose. N is a water-tight chamber filled with concentrated solution of alum containing also a few loose crystals of alum, which are dissolved when the temperature rises; the hypothenuse of this triangular chamber is occupied by the plane mirror Q, which reflects the light upwards through the plano-convex condensing lens R of short focal length, which illuminates the object with a convergent beam of light from the electric lamp. After the rays have traversed the objective they enter a rectangular prism S, by which they are reflected in a horizontal direction and throw an image upon the screen; the prism S being adjusted by means of a screw and hinge.

This instrument may conveniently be used not only for demonstration, but also for photographing, by allowing the rays to enter an ordinary

camera from which the objective has been removed; and the author suggests its employment to demonstrate the phenomena of electrolysis (fig. 40).

A A are mercury connections which receive the wires from a battery of six small Grove's cells; a rheostat, contact-breaker, and commutator being included in the circuit. The current is conveyed from A A by *a a* to B B, two

Fig. 40.

vessels of mercury, which are insulated and fixed upon C a plate with a hole in its centre, which rests upon the stage. D is the object-carrier, on which a drop of the solution is placed, being then covered with a flat watch-glass E, having its convex side downwards; the electrodes are formed by the wires *e e*, terminating in arrow-shaped platinum points, which are brought into contact with the drop. Any desired movement is given to the object by the motion, not of D, but of the plate C. The mercury connections obviate the pressure or elasticity which would be introduced by solid connections.

Nelson's "New Student's Microscope."—Mr. E. M. Nelson claims * that this instrument "begins a new era in the progress of 'microscopy,'" and that for the "first time in the history of the Microscope a thoroughly sound full-sized instrument" can be supplied at the same price as a student's Microscope.

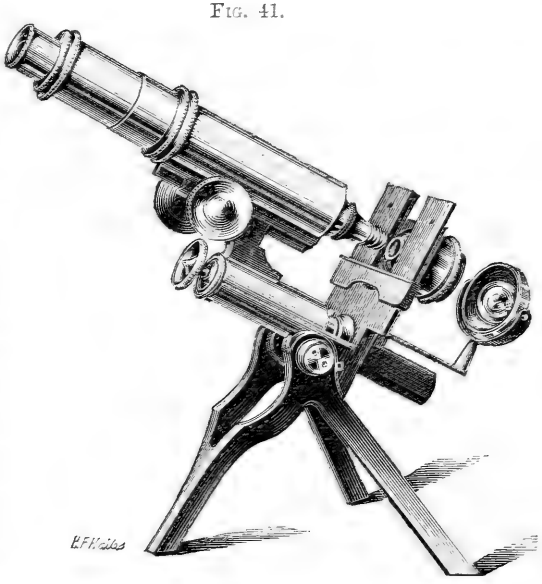
Referring to some of the points adopted in this new Microscope—points where there must of necessity be much that is old in design—Mr. Nelson divides Microscope feet into four classes:—1st. The simple tripod, illustrated by the Powell form. 2nd. The plate and uprights. A flat plate with pillar or pillars, as in the Beck model; and a plate with flat uprights, as in the Andrew Ross. 3rd. The bent claw, a very common and bad form, used by many makers. 4th. The heavy horseshoe, the usual Continental model. The plate and uprights, though a good form, was not adopted because it was too heavy and expensive. The bent claw is a bad form: it is heavy, easily capsized, and while seemingly a tripod, often rocks on four points. The heavy horseshoe which, until lately, was always fitted to students' Microscopes, has nothing to recommend it. A designer, Mr. Nelson considers, "must indeed be hard up for resources who can only obtain steadiness by weight. There can be no question but that the tripod in its simplest form is the best. Of all the ways of utilizing it, that adopted by Messrs. Powell and Lealand is the most efficient, viz. of hanging the Microscope in a horseshoe, supported by three legs; but that for this class of instrument was quite out of the question, for cost immediately puts it outside the category of students' Microscopes.

There is a great difference between the steadiness of a Microscope perched up on the top of its trunnions, and one that is hung in a tripod. The new Microscope (fig. 41) is placed in a kind of stirrup hanging from the trunnions. . . . The body is large enough to take Zeiss's full-sized eyepiece, viz. $1\frac{3}{8}$ in., and is 10 in. long when the draw-tube is pulled out to a mark. When the draw-tube is pushed home, the length is 6·3 in., or Continental gauge. It, therefore, will suit both kinds of apochromatics. The optic axis of the instrument, when in a horizontal position, is $8\frac{1}{2}$ in. from the table. It has rackwork coarse-adjustment, and Campbell's fine-

* Cf. Eng. Mech., xliv. (1887) p. 497.

adjustment. It is to this fine-adjustment that the instrument owes its origin. The moment Mr. Campbell explained to me the principle of his fine-adjustment, I foresaw the construction of an efficient student's Microscope. The direct-acting screw is only suitable for low powers and small apertures. I will put it even stronger: delicate work with high powers and wide apertures is not possible with any Microscope having a direct-acting screw fine-adjustment.

FIG. 41.



The stage is of the cut horseshoe form. . . . The principal object of it is to enable you to feel your working distance. Let me point out a great improvement in the sliding bar. Its guiding lugs are stowed away underneath the stage; I have no hesitation in saying that next to a perfect mechanical stage this is the best. Most of the mechanical stages are so defective in design, and so scamped in their workmanship, as to be worse than useless.

The substage is fitted with a tube, having a spiral slot for focusing. . . . There is a novel feature about the stops for dark-ground illumination, viz. there is a three-legged carrier which holds them all. This carrier has a pin in the centre of it on which the various sized discs fit. The stops, diaphragms, &c., have a separate tube-fitting for them, so that it is unnecessary to move your condenser when changing either a stop or a diaphragm. This substage will carry either of Prof. Abbe's condensers, or a cheap condenser made especially for this Microscope. The weight of the Microscope is 7 lbs. complete."

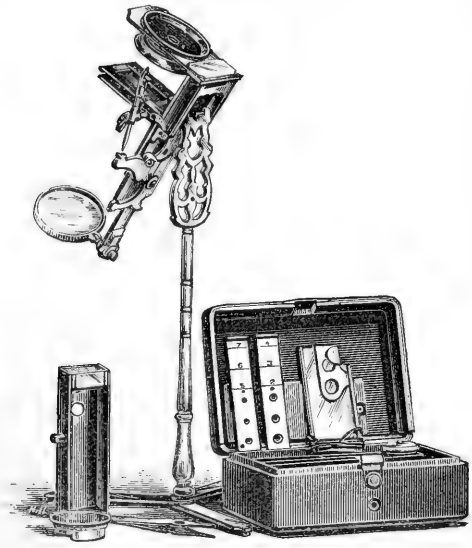
The instrument is made by Mr. C. Baker, of High Holborn, and has been brought out under the personal superintendence of Mr. C. L. Curties. Since the original issue, Mr. Baker has added to the completeness of the design by the application of a rack and centering movements to the substage, and also Mayall's removable mechanical stage.

Lindsay's Simple Microscope.—In the Journal for 1883, p. 708, we reproduced from a German publication two figures of Lindsay's Microscope, which we have since found were probably taken from the specification of the patent granted to George Lindsay in 1742, the first patent known in England relating to a Microscope. As the general design of the instrument is not readily understood by inspection of those figures, we here give a perspective view (fig. 42) of a highly finished model in silver by Lindsay, which we met with in our recent visit to Italy.

The optical arrangement consists (1) of a low-power lens provided with a Lieberkühn (one of the earliest applications of this device after its

introduction by Dr. N. Lieberkühn, in 1738), which slides beneath the cross-arm on the top of the instrument; (2) of two sliding plates each provided with three different powers, numbered from 2 to 7, also sliding beneath the cross-arm; (3) a perforated conical reflector, acting after the manner of a Lieberkühn, which can be applied in conjunction with the low-powers in one of the sliding plates. The mirror is concave, and is hinged on a pivot applied in a socket at the end of the sliding tail-piece. The focussing is by means of a bent lever at the back moving the stage up or down. The limb is hinged at the back to incline on an ornamental support fitted to rotate on the pillar and tripod. A fish-plate, a silver box with perforated sliding lid, articulated stage-forceps, hand-forceps, ivory box for talcs and rings, and six object-slides, together with the whole Microscope, pack neatly in a box about $3\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in.*

Fig. 42.



Garrison, F. L.—See *infra*, β (2).

Howland, E. P.—[**Microscopic Projection.**]

["My experience leads me to believe that the direct projection of microscopic objects can only be successfully accomplished in small rooms. For public exhibitions and for projection generally photographs are to be preferred. The use of a projecting Microscope is quite satisfactory with low powers, but it is difficult to concentrate the light sufficiently to admit the use of high powers. These remarks refer to the use of calcium light. With the electric light better results may be obtained."]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 38–9.

Pe.—**Ausstellung wissenschaftlicher Apparate, Instrumente, und Präparate.** (Exhibition of Scientific Apparatus, Instruments, and Preparations.) II.

[Exhibition at Berlin. Includes an Electrical Arc Lamp with Microscope—Stricker's Electrical Projection Microscope—Nehmer's Incandescence Lamps—Microscopes by Schieck & Wannbrunn and Quilitz & Co.]

Zeitschr. f. Instrumentenk., VI. (1886) pp. 425–31.

Cf. "W.," *ante*, p. 161.

Pfeffer, W.—**Bezugsquelle und Preis einiger Apparate.** (Place to obtain and price of some apparatus.)

[Includes Microscopes.] *Bot. Ztg.*, XLV. (1887) pp. 27–31.

(2) Eye-pieces and Objectives.

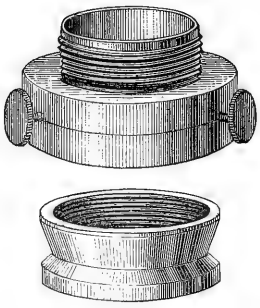
Frazer's Centering Nose-piece for use with Double Nose-pieces.†—"When the nose-piece is moved in the usual way, and one objective put in place of another," writes Mr. A. Frazer, "it seldom happens that an object which was in the focus of one power is also in the focus of the other; and, as a consequence, the operation of focusing must be performed. This

* Cf. Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 43 (1 fig.).

† Trans. Edinburgh Naturalists' Field Club, i. (1885-6) pp. 333–5.

defect may be remedied by making the sides of the nose-piece which hold the objectives of unequal lengths, or by putting an adapter in either side and so correcting for the difference of adjustment for focus. When this correction has been made the convenience of the nose-piece is much increased; but the error of want of concentricity may still remain, i. e. a particular point in the middle part of the field of the lower power may not also be in the centre of the field of the higher. The appliance now described has been designed to remedy the defects both of want of centre and error of focus. It consists of an outer brass collar, which in its upper part is provided with a screw which fits one of the screwed ends of the nose-piece, and in its lower part consists of a brass collar, which is provided with three mill-headed steel screws, placed at regular intervals in its circumference. These screws control an inner ring, into which the objective is screwed, and which may be moved laterally by means of the steel screws. This inner ring, and also the outer ring which supports it, may be made of any suitable length, and by this means the accurate adjustment for focus is effected; while the inner ring being, as already mentioned, capable of a lateral movement, the adjustment for 'centre' may also be accurately made."

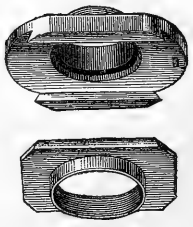
Fig. 43.



Turnbull's Improved Sliding Nose-piece and Adapter.*—The Royal Scottish Society of Arts has awarded a silver medal to Mr. J. M. Turnbull for this apparatus, which he thus describes:—

"It consists essentially of a small face-plate or 'chuck,' which screws into the ordinary 'nose' of the Microscope, fig. 44. On its face this has a slide, which has fitted into it another sliding-piece, and into which the objective is screwed. As many of the other objectives as belong to the instrument are fitted with similar sliding-pieces, which also fit into the first. Once, therefore, an objective is fitted and centered with one of these sliding-pieces, having a sufficient length of tube to bring it very nearly into focus, it can be substituted in a moment for one of lower or higher power, as the case may be; and if an object has been previously centered on the stage with a low power, it will be found accurately centered in the field of that of the higher. I also wish to draw your attention to the fact that all the face parts of this appliance are finished on the lathe, which enables the optical axis of the eye-piece, instrument, and objective to be truly maintained, and does away with the failings of the ordinary double nose-piece in this respect. Another form of this adapter is to have two, three, or more objectives mounted together on one of the sliding-pieces, having on each objective a sufficient length of tube to bring it accurately into focus, and sliding one objective on another, as may be wished, central with the tube of the instrument, a small spring-point retaining it in that position. It is a matter of choice, however, as to which is the better form—whether it will be more convenient to have two or three objectives mounted together, or to have them separate.

Fig. 44.



Having thus described the appliance, I think I may fairly claim for it that it will change the objective of a Microscope with great rapidity, with

* Trans. Edinburgh Naturalists' Field Club, i. (1885-6) pp. 335-6.

very accurate centering, and very close approximate focusing. Having made these claims for it, I commend the apparatus to the attention of all workers with the Microscope, whose time is generally too valuable to waste on matters such as this."

Wales's Cover-carrier for Immersion and Dry Lenses.*—Mr. W. Wales, in exhibiting a non-adjustable 1/5 in. objective with a cover-carrier or cap, said that the idea of affixing a cover-carrier to a lens occurred to him because of the fact that opticians are frequently held responsible for errors of the manipulator in the use of non-adjustable lenses—that a non-adjustable lens corrected for a 10 in. tube would sometimes be used on an 8 in. tube, and this failing to produce good results, the optician would get the credit for making a poor lens. Hence he had fitted a cover-glass to a cap made to screw on to the front cell, or fitting over the objective, and had adjusted and corrected the lens for that particular cover-glass, so that the objective could be plunged down into any fluid without injuring it, and would always be correct for a 10 in. tube without adjustment.

In using an oil-immersion lens with the cover-cap, a drop of oil is placed on the inside of the cover-glass, and the lens can be used in urine, blood, or other liquids. The oil can be allowed to remain there if the lens is perfectly tight, saving time and trouble in repeated examinations of this kind. The cap also serves as a protection to the lens. It can be easily removed and cleansed at any time, and the cover-glass can be replaced if broken.

Paper for Cleaning the Lenses of Objectives and Oculars.†—Prof. S. H. Gage for the last two years has used the so-called Japanese filter paper (the bibulous paper often used by dentists when filling teeth) for cleaning the lenses of oculars and objectives, and especially for removing the fluid used with immersion objectives. Whenever a piece is used once it is thrown away. It has proved more satisfactory than cloth or chamois, because dust and sand are not present, and from its bibulous character it is very efficient in removing liquid or semi-liquid substances. At the author's suggestion it was tried in the Bureau of Animal Industry at Washington, and is now used there almost exclusively.

DALLINGER, W. H.—**The value of the new Apochromatic Lenses.**
[Extract from Presidential Address, *supra*, p. 185.]
Nature, xxxv. (1887) pp. 467–9.

FORGAN, W.—**Notes on Microscope Objectives.**
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 326–9.

LAURENT, L.—**Sur l'exécution des objectifs pour instruments de précision.** (On making objectives for instruments of precision.)
Comptes Rendus, CII. (1886) pp. 545–8 (2 figs.).

NELSON, E. M.—**Object-glasses.**
["For bacteriological work two lenses are absolutely necessary, and a Microscope fitted with a condenser. I consider the condenser so important that I would rather have an indifferent lens with a condenser than a first-rate lens without. A cheap and excellent combination is Seibert Nos. 3 and 7, viz. a 1/2 N.A. 0·32 and water-immersion 1/16 N.A. 1·07. These two glasses cost a little under 5*l.*, and if you know how to test them you can get two first-rate lenses. A third lens is very useful, as the interval between a 1/2 and 1/16 is rather wide. The best lens to put in is a Reichert No. 7*a*; this is a 1/7 of N.A. 0·84. I think its price is about 2*l.* The next series of three, costing about 9*l.*, would be Zeiss A.A., D.D., and G. These are a 2/3 of N.A. 0·31, a 1/6 N.A. 0·82, and a 1/9 N.A. 1·16. These also require selecting."]
Engl. Mech., XLIV. (1887) pp. 562–3.

SCHULZE, A.—**On Abbe's Apochromatic Micro-objectives** and compensating eye-pieces made of the new optical glasses in the works of Dr. Carl Zeiss in Jena, with some general remarks on object-glasses.
Paper read to Glasgow Phil. Soc., 17th Nov., 1886, 13 pp.

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* Journ. New York Micr. Soc., ii. (1886) pp. 125–6.
† The Microscope, vi. (1886) p. 267.

(3) Illuminating Apparatus.

Jones's Radial Swinging Tail-piece.*—The principle of causing the illumination to move radially upon the object from the axis to near the horizon and above, as illustrated in Grubb's Sector Microscope,† and subsequently by Nachet (Thury), Zentmayer, Tolles, Bulloch, and others, appears to have been anticipated in the last century in a Lucernal Microscope, designed by "the Rev. John Prince, LL.D., now of Salem, Massachuset's States, North America," and constructed by W. and S. Jones, the application of the lamp being suggested by "Mr. John Hill, Wells, in Norfolk." ‡

FIG. 45.

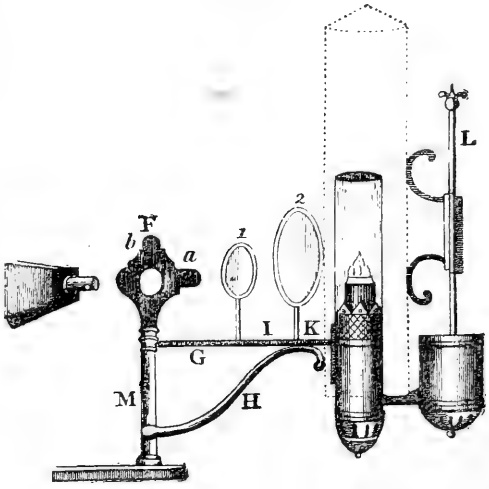


Fig. 45 shows the tail-piece as figured by Adams in plate ix. fig. 5 of the second edition of his 'Essays on the Microscope.' The stage F is supported by a rod passing through a socket M, and attached to a bar, forming a continuation of the limb carrying the projection-box or camera of the Microscope; G I K is the tail-piece connected with the socket M, and strengthened by the bracket H, carrying condensers 1 and 2, and the lamp L. The tail-piece swings laterally round the axis of F, and thus gives radial illumination upon the object on the surface *b a* of the stage.

In what appears to have been an original form of the apparatus which we have seen, a mirror was fitted to slide upon the tail-piece, but no lamp was applied. To the apparatus furnished with a lamp a tablet is attached, notifying that Mr. John Hill had devised the arrangement.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig.).

N., W. J.—**The Two Mirrors. IV.** [*Post.*]
Sci.-Gossip, 1887, pp. 25–7, 52–4 (3 figs.) (*contd.*).

Stricker's Electric Lamp.
["In lecturing before the Society of Natural History at Berlin, Prof. Stricker has employed with much success an electric lamp of 4000 candle power for the projection of microscopic sections upon a screen, employing a magnifying power of 6000 to 8000 diameters. It is stated that the definition obtained is very satisfactory." Cf. Journal, 1886, p. 502.]
Science, IX. (1887) p. 55, and see Pe, *supra* (1).

(4) Other Accessories.

Haswell's Rotating Stage and Circular Slides for large Series of Sections.—This apparatus was more especially designed by Mr. W. A. Haswell for the purpose of enabling students conveniently to examine series of sections of objects which they have not the opportunity of sectioning for themselves. It is thus more particularly intended for special

* Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, p. 58 (1 fig.). † See this Journal, 1880, p. 1056.
‡ See Adams's 'Essays on the Microscope,' 2nd ed., 1798, p. 84.

type-series of sections of such objects as, when cut into thin sections, would occupy a very large number of slides of the ordinary form,—such as the earthworm, leech, fluke, *Amphioxus*, chick, mammalian embryos, and the like: but besides its use for demonstration purposes it is also claimed to be of the greatest service in investigation.

The sections are mounted on circular discs of glass *a*, figs. 46 and 47, 9 in. to 11 in. in diameter, with a circular aperture of 3 or 4 inches in the centre. The method of procedure is as follows:—The glass disc after being carefully cleaned is smeared over thinly with a very thick solution of shellac in creosote. It is then laid on a sheet of white paper on which concentric circles a quarter of an inch or thereabouts apart, from the size of the disc downwards, have been ruled. The sections, cut by an automatic microtome, are laid round the outer edge of the disc in concentric circles, their position being regulated by the concentric lines on the paper. To facilitate the arrangement of the section it is advisable in paring down the block of paraffin to leave the sides not quite parallel, but inclined to one another at

Fig. 46.

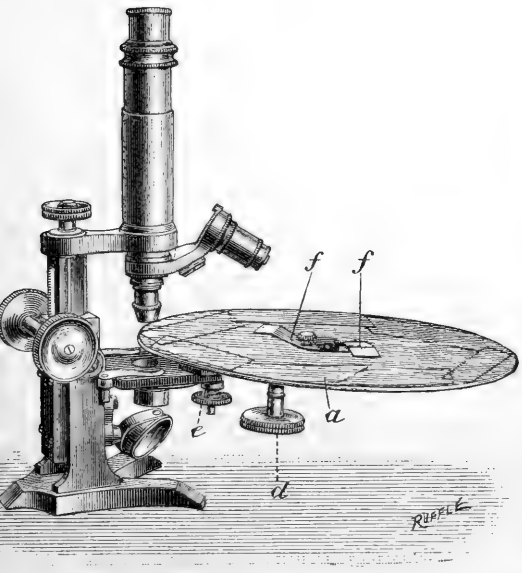
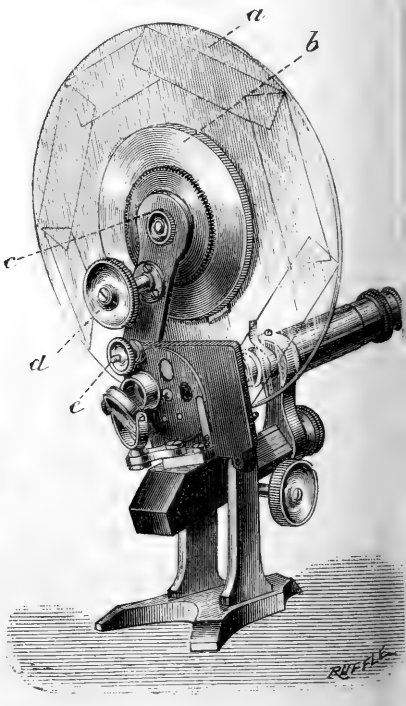


Fig. 47.



about the angle between two radii of the disc separated near the circumference by the thickness of the block; by this means is produced a ribbon of sections which is not straight but curved, with about the curvature required. The disc is then warmed in the usual way to dry the creosote and melt the paraffin, and is flooded with turpentine to dissolve out the latter: balsam is poured on and the sections are covered with oblong strips of thin cover-glass. In this way may be regularly arranged on the disc a series containing thousands of sections.

The apparatus for enabling the series to be examined is a brass revolving

table *b* carried on a horizontal arm *c*, which is fastened to the right-hand corner of the stage of the Microscope by a screw passing through a hole in the stage and provided with a nut *e*. The glass disc is centered on the circular table and fastened with a pair of spring clips *f f* placed near the centre. The table, carrying with it the disc, is rotated by a rack and pinion or rather cog-wheel movement, worked with the right hand by means of a milled head *d* placed underneath. The concentric circles of sections are brought under the tube by the movement of the horizontal arm, by means of which the centre of the revolving table is brought nearer to or carried further away from the centre of the stage.

Warm and Cold "Stages."—In studying the anatomical elements of a warm-blooded animal, and other phenomena which naturally occur under the influence of a temperature considerably above that of the surrounding air, it is necessary to have some means of maintaining a condition as to temperature resembling that of the living organisms, or even, as in the experiments of Dr. Dallinger, described *supra*, p. 185, of raising the temperature to an abnormal point. We summarize here some of the principal suggestions that have been made for this purpose (as well as for producing cold), excluding such as have previously been recorded in this Journal.

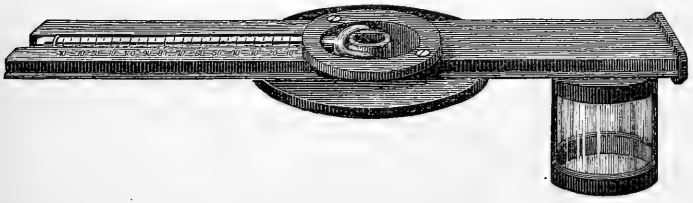
A very crude process described by Raspail * was to put the object in water in a watch-glass on the stage, a spirit-lamp being placed beneath it, which served both for heating the water and giving light to the object. The objective was covered by the globular end of a thin glass tube, which dipping into the water, prevented the obscuration of the object by vapour and protected the objective. Harting,† following, but not quoting, Goring and Pritchard ‡ proposed to substitute for the glass tube a brass one, closed by a plane plate of glass. Schacht § also heated the slide direct by a minute wax taper placed (for short periods) below the opening in the stage.

Apart from these methods, four different principles have been adopted for heating microscopic objects: (1) by hot air; (2) by electricity; (3) by conduction through metal plates; and (4) by water.

1. *Air.*—This is perhaps the least convenient medium of all for heating microscopic objects.

Prof. G. Fritsch commends *Dr. Senarmont's* ‖ apparatus as a very simple and handy stage, which "in its arrangement is to be preferred to those of Max Schultze and Stricker." It consists (figs. 48 and 49) of a hollow

Fig. 48.

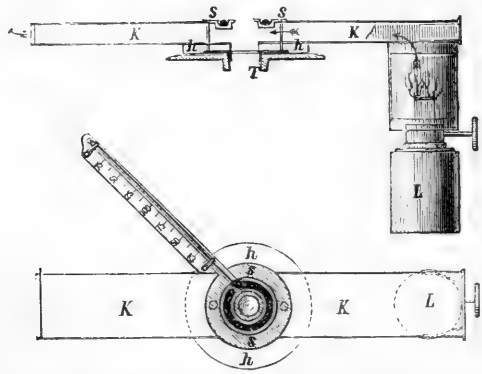


box of tin K, open at one end, and having at the other an aperture in the lower surface, to which is attached a cylindrical tube of mica. The box is

* Raspail, L. V., 'Nouveau Système du Chimie Organique,' 2nd ed., i., 1838, pp. 222–3 (1 fig.).
† Harting, P., 'Das Mikroskop,' 2nd ed., ii., 1866, pp. 146–7 (1 fig.).
‡ Goring, C. R., and Pritchard, A., 'Microscopic Illustrations,' 1830, pp. 55–6 (2 figs.).
§ Schacht, H., 'Das Mikroskop,' 3rd ed., 1862, p. 79.
‖ Bericht u. d. Wiss. Instrumente a. d. Berliner Gewerbeausstellung im Jahre 1879 (Löwenherz), pp. 305–6 (1 fig.), and pp. 355–6 (1 fig.).

pierced with a circular aperture in the centre, that in the upper surface being open, and that in the lower closed by a plate of glass. On the top is screwed a plate *s*, with a deep annular groove to hold the thermometer-bulb, the tube of which lies in a groove along the upper surface of the box to the left. A lamp L is placed under the mica cylinder, and thereby warm

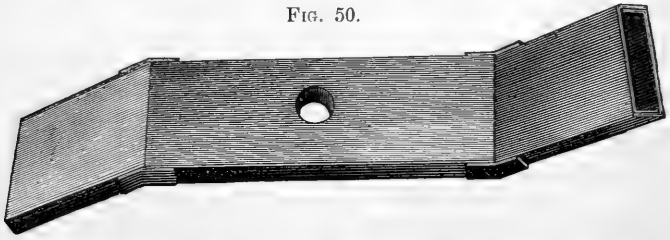
Fig. 49.



air is made to pass through the box, the heat being transmitted from the centre plate into the object laid upon it. It is isolated from the stage T by means of an ebonite ring *h*.

Dr. Beale also in 1865 * described and figured a simple plan (fig. 50) of heating objects by hot air. It consists of a long copper box, open at both ends, the middle part of which lies flat on the stage One end is bent down obliquely so as to project over the side of the stage, while the other is similarly bent up. A spirit-lamp being placed at the lower end a current

Fig. 50.



of hot air passes through the box and escapes at the upper end. The centre of the box has its lower wall composed of glass, while at the upper part is an opening to allow of the hot air reaching the slide.

Valentin's stage described under (4) Water *infra*, can also be used as a hot air stage.

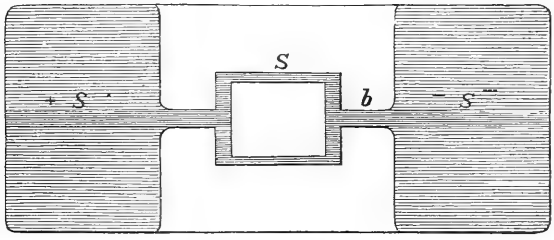
2. *Electricity.—Prof. S. Stricker* recommends † the use of electricity as a means of heating a stage, thus describing it:—A better method than any consists in the conversion of a constant current of electricity into heat. In microscopical investigation only a very small absolute quantity of heat is required, and indeed it is not necessary to warm the stage in its whole extent, but only its centre, or what is still better, the cover-glass placed on

* 'How to work with the Microscope,' 3rd ed., 1865, p. 129 (1 fig.). See also 5th ed., 1880, p. 189 (1 fig.).

† Stricker, S., 'Manual of Human and Comparative Histology.' Transl. by H. Power, 1870, pp. xii.-xvii. (3 figs.)

a slip of caoutchouc. An amount of heat so small as this we may reasonably expect to obtain from the interruption of even feeble currents of electricity. It is well known that the heating of a wire introduced into the arc of a constant current increases with the diminution in diameter of the wire. For this purpose, therefore, we employ a proportionately thin wire attached to the centre of a glass plate, the ends being in connection with the electrodes of a constant battery. When the current is closed the temperature of the centre of the glass plate is raised. The attachment of the wire presents, however, certain inconveniences, and we possess in tin-foil a more appropriate means at our disposal. The tin-foil should be cut into the form represented by S in fig. 51, and then glued to a glass slide; the

FIG. 51.

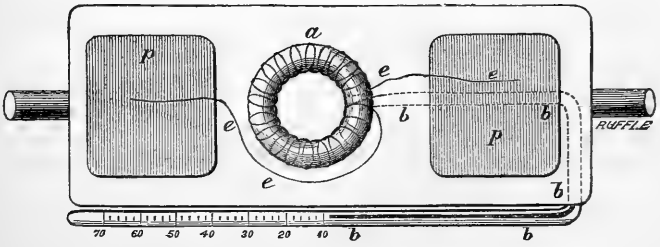


extremities of the tin-foil being introduced into the arc of a constant current. A second strip of tin-foil of the same breadth as that attached to the slide *b*, is wound round the bulb of a thermometer and introduced into the circuit at any convenient point. This furnishes the means of correctly estimating the temperature attained by the centre of the slide when all the secondary conditions are uniform. These latter can, however, be estimated by comparison and the due employment of a thermometer—a proceeding that is always requisite whatever may be the mode of heating employed. In order to accomplish this, a fatty substance, the melting point of which is known, should be placed at the point where the object is situate, and the reading of the mercury should be taken at the moment that the fat begins to melt.

As the temperature diminishes as the square of the strength of the current, this decrease can to a certain extent be covered by diminishing the transverse section of the tin-foil, so that if a weak current be in use the strip of tin-foil must be made proportionately narrow.

In order to exercise a direct control over the temperature of the cover-glass, a thermometer should be attached to the slide itself. In fig. 52, *a* is

FIG. 52.

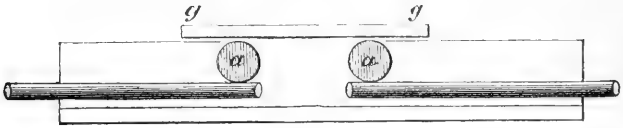


the bulb of the thermometer, the dotted line *b* indicating the direction of the tube. Both the tubes and the bulb lie in a groove made in a hard caoutchouc slide. A coil of very fine copper or platinum wire *e* is wound

round the bulb and the ends lie on the metal plates *p p*, which are also connected with the electrodes.

Fig. 53 also gives a longitudinal section of the stage; *g g* is the cover-glass upon or to the under surface of which the object to be examined is fixed. The cover-glass is in contact not only with the surface of the

FIG. 53.



slide, but also with the coil of wire surrounding the bulb of the thermometer the transverse section of which is seen at *a a*. When the circuit is closed the wire becomes heated and acts on the one hand upon the mercury, and on the other upon the cover. The hard caoutchouc is a bad conductor of heat, and hence the cover-glass receives the greater part of the heat.

FIG. 54.

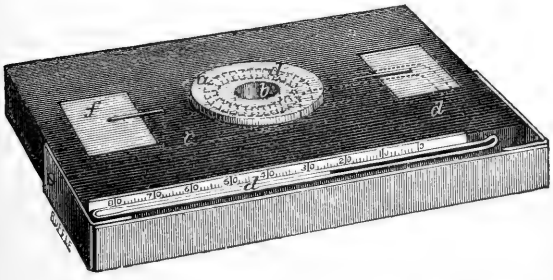


Fig. 54 shows the Stricker stage as figured in the 'Handbook for the Physiological Laboratory,'* *b* being the central chamber (surrounded by a copper disc *a*) warmed by the current, *f* a copper plate with a corresponding one on the other side to which the electrodes are applied, *c* a platinum wire by which the two plates are in communication and which is coiled round the bulb of the thermometer *d*.

Dr. S. T. Stein † also uses a platinum spiral (fig. 55) inserted between

FIG. 55.

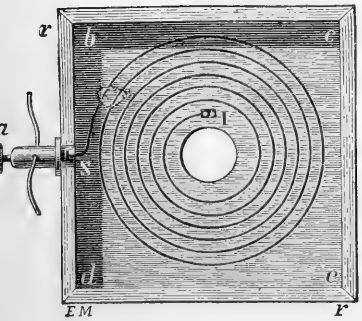
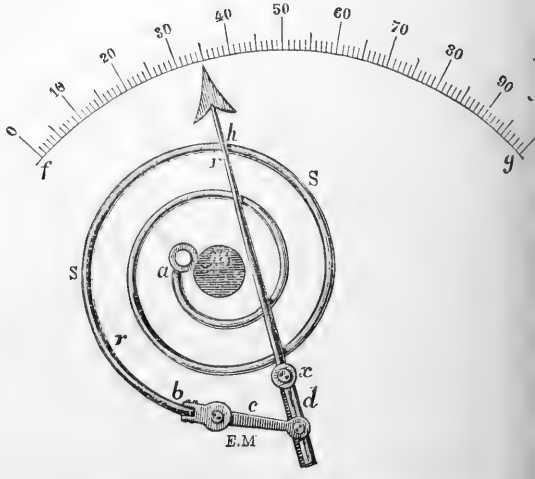


FIG. 56.

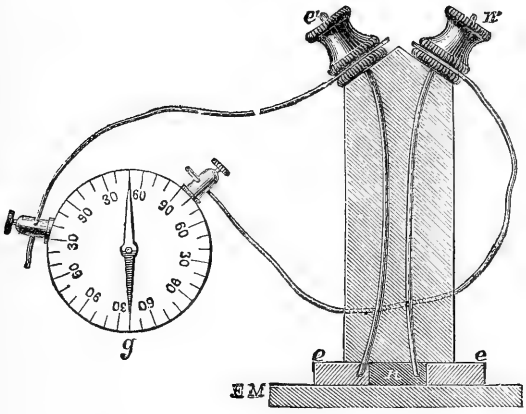


* Burdon-Sanderson, J., E. Klein, M. Foster, and T. L. Brunton, 'Handbook for the Physiological Laboratory,' 1873, fig. 14.

† Zeitschr. f. Wiss. Mikr., i. (1884) p. 161.

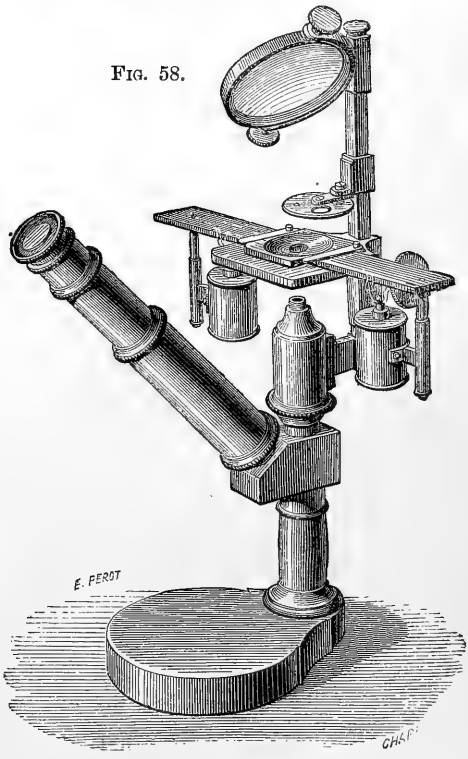
the upper and lower plates of the stage of a Microscope, and heats it by the electric current. To measure the degree of heat, he employs the bi-metallic thermometer (fig. 56). The spiral is made of brass S and iron *r*

Fig. 57.



soldered together, and by the difference of expansion in the two metals the spiral contracts or opens. The inner end *a* is attached to the stage close to its opening, while the free end *b* acts, through an arm *c*, on an index *d* which is pivoted at *x*, and whose point *h* moves along the scale *f g*. Or the thermo-electric apparatus (fig. 57) may be used, where *e e* is iron and *n* German silver, two wires *e'* and *n'* leading to the galvanometer *g*, the needle of which is deflected more or less, according to the temperature of the stage.

Fig. 58.



3. *Hot Plates.—M. C. Chevalier's* * is shown in fig. 58. It consists of a metal plate with a central aperture, beneath the two ends of which are placed spirit-lamps which slide up and down on the projecting stems. This apparatus was intended for use with Chevalier's Universal or Chemical Microscope (a modified form of the latter shown in fig. 58), in which the objective is beneath the object. One or

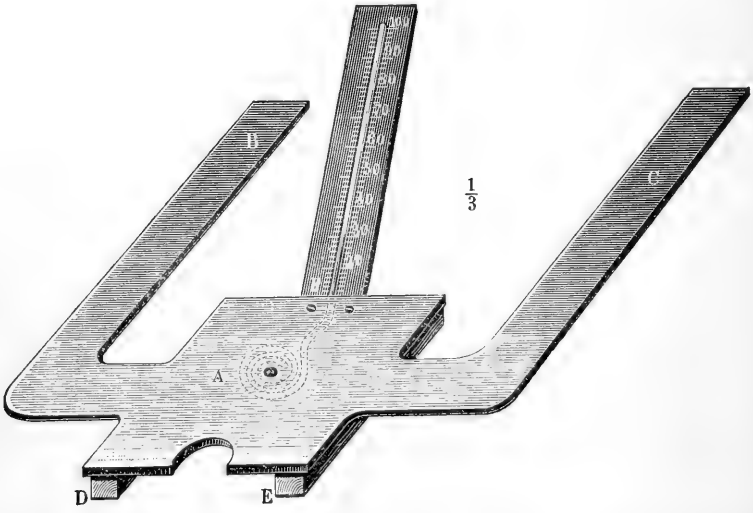
* Chevalier, C., 'Des Microscopes et de leur usage,' 1839, p. 97 (1 pl.).

both of the lamps can be used according to the degree of heat required, and a thermometer can be applied if desired.

Prof. Max Schultze's * (fig. 59) is figured in most foreign treatises, and was the first fairly successful hot stage.

It consists of a brass plate A, 1–2 mm. thick, notched behind so as to fit to the pillar of the Microscope, and attached to the stage by clamps. It has two arms B C, 170–200 mm. long and 30 mm. broad, bent forwards at

Fig. 59.



right angles. Spirit-lamps are placed under the ends of these arms and an object on the plate (then elevated 10 mm. above the stage) can be readily raised to a temperature of 35°–45° C. A small hole at A allows light from the mirror to pass to the object, the temperature of which is recorded † by a thermometer F, rising obliquely above the stage, the bulb being wound twice round the aperture at A. The upper part of this bulb is flat, so as to lie close to the central plate, and the bulb is inclosed in a box or cover to protect it from changes in the external temperature. Two wooden ledges D E at each side of the box, support the apparatus on the stage and retard the abstraction of heat through the stage. This apparatus has a special defect according to Engelmann. The temperature of the object is occasionally reduced very considerably by the metallic setting of the lens and the body-tube, so that the focal distance of the objective exerts a marked influence on the observations. The insertion of a bad conductor of heat between the lens and the body-tube has been proposed. An ivory tube 30 mm. in height applied in this manner lessens the defect very materially.‡

Dr. Ransom in order to employ the stage for cold also, suggests making it of copper instead of brass, the former metal being so much better a

* Arch. f. Mikr. Anat., i., 1865, p. 1; Frey, H., 'Das Mikroskop,' &c. Transl. by Cutter, 1880, pp. 101–2 (1 fig.); Harting, op. cit. pp. 147–8 (1 fig.); Dippel, L., 'Das Mikroskop,' 2nd ed., 1882, pp. 653–5 (1 fig.); Robin, C., 'Traité du Microscope,' 1877, pp. 161–2 (1 fig.).

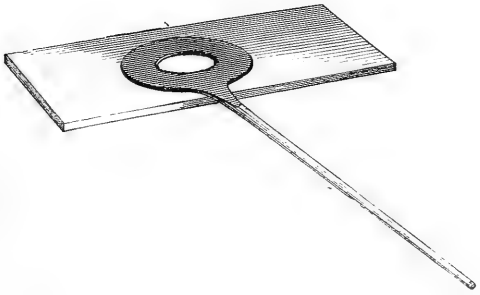
† Frey says "wirklich" and Ranvier "approximativement."

‡ See Frey, op. cit., pp. 101–2.

conductor,* while *Sig. Koritska* of Milan makes the ends of the arms B C terminate in discs, to give an extended heating surface.

Prof. Stricker's first form † consisted of a copper ring or rod inserted into a glass slide so as not to project beyond the surface. A second rod with a spiral coil is slipped over the free end of the first rod, and its extremity heated by a spirit-lamp. This has been further simplified ‡ by making the ring and rod in one piece, as shown in fig. 60.

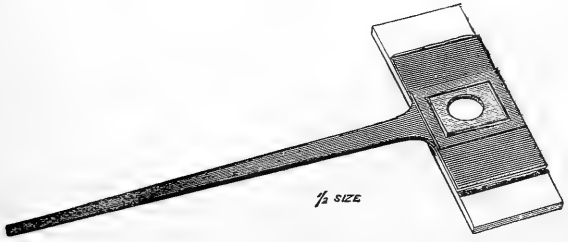
Fig. 60.



Two simple modifications of this form are also shown in figs. 61, 62, and 63.

The first § (figs. 61 and 62) has an oblong copper plate 2 × 1 in., from one side of which projects an arm of the same metal 4 or 5 in. long. The plate has a round aperture in the centre 1/2 in. in diameter, and is fastened to an ordinary slide by sealing-wax. The rod is heated near

Fig. 61.



its end by a small spirit-lamp as shown in fig. 62, and the heat is conducted by the rod to the copper plate, and from this to the preparation. If an object is under examination, such as white blood-corpuscles, which it is desired to warm to about the temperature of the body, a small fragment of a mixture of white wax and cacao-butter melted at about 30° C., should be placed upon the copper (fig. 62). The lamp is now gradually approached along the rod until it arrives at a point, the heat transmitted from which is just sufficient to partially melt the fragment, and it is then left burning at that spot.

The other form (fig. 63) consists of a square copper plate *b* with a central opening *c*. A rod *e* projects from its under surface (upper as

* Beale's 'How to work with the Microscope,' 5th ed., 1880, p. 189.
† Op. cit., pp. xvii.–xviii. (1 fig.). ‡ Burdon-Sanderson, op. cit., pp. 6–7 (1 fig.).
§ Schäfer, E. A., 'A Course of Practical Histology,' 1877, pp. 18–20 (2 figs.).

seen in the drawing), and fits into a groove in the glass slide *a*. A pin *d* also fits into a hole at the end of the groove. The rod is heated by a spirit-lamp.*

FIG. 62.

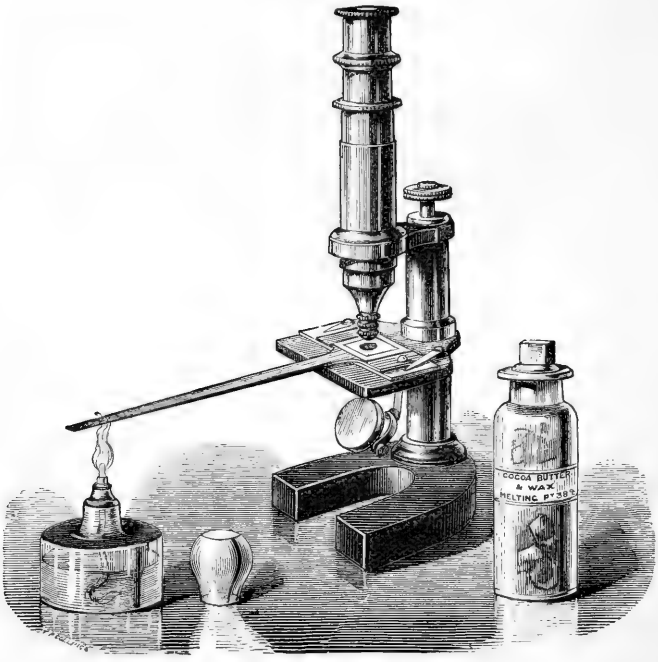
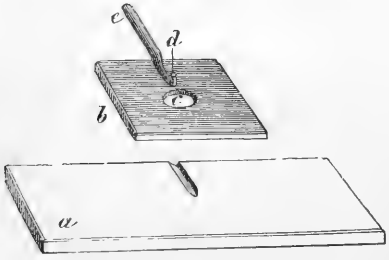


FIG. 63.



Prof. Stricker's more complete form † is shown in fig. 64. It consists of a block of black vulcanite $3 \times 1\frac{1}{2} \times 1/4$ in. The central cylindrical chamber *b* is closed below by a glass plate and surrounded at the top by a copper disc *a*. The bulb of the thermometer passes round the chamber, as shown by the dotted line *d*. Its capillary tube lies in a trough, one side of which is formed by the back of the block and the other by a metal plate screwed to it, the form of which is shown in the fig. The tube *c* (for gases) leads into the chamber, and a second tube leads from it through the projecting metallic arm shown at the top. This arm, which is

* Burdon-Sanderson, op. cit., fig. 12.

† Stricker, op. cit., pp. xvii.–xviii. (1 fig.). Burdon-Sanderson, op. cit., p. 7 (fig. 2).

in one piece with the disc *a* is of such a size that the rod *g*, fig. 65, fits in it by means of the spiral *f*, and by this rod the chamber is heated.*

Fig. 64.

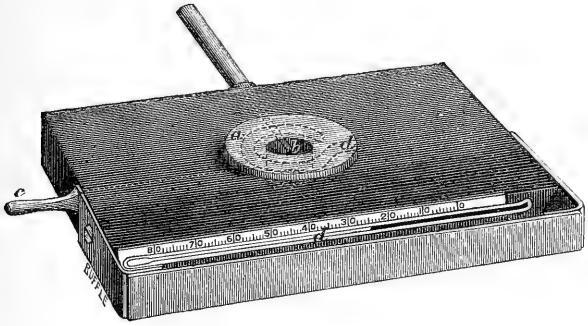
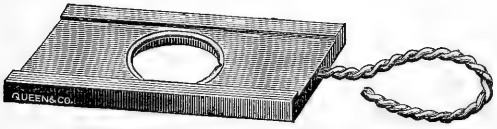


Fig. 65.

Mr. J. S. B. Bell also recently suggested † a modified arrangement for maintaining the preparation at any temperature from that of the room up to 100°. It consists (fig. 66) of a mahogany slide 3 × 1½ × 1/4 in., with a flat groove 1/16 in. deep for the ordinary glass slide to lie in. In the

Fig. 66.



centre is a round hole 1 in. in diameter, which incloses a copper ring, made by bending No. 16 wire into a ring slightly less than the hole. The two ends pass longitudinally through the stage and are twisted together and curled round. The stage is heated by a spirit-lamp held to the twisted wire, and when the required temperature is reached the lamp is moved back along the wire to a point that will just maintain the temperature. At the time the stage was exhibited, the room was 62° F.; the slide was heated to 82°, and the temperature kept stationary. It was then heated to 100°, and kept stationary for half an hour. In this arrangement the heated wire is isolated from the stage and from the glass slide by means of the wood in which it is placed.

Mr. W. H. Symons' first form of stage ‡ for steam, water, a saturated

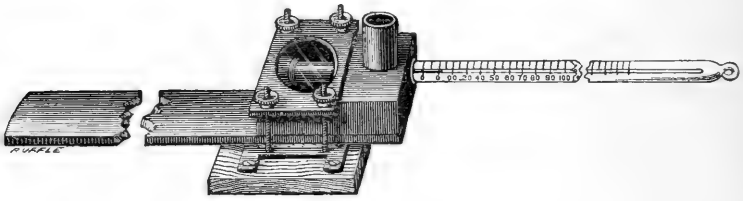
* Dr. C. H. Golding-Bird in 1875 suggested (Quart. Journ. Micr. Sci., xv., 1875, pp. 373–4) a "differential" warm stage made with copper and iron wire, and intended to correct the error which he considered the preceding forms of stage to give rise to, by reason of the difference of temperature between the copper and the centre of the glass slide.

† Micr. News, iv. (1884) pp. 19–20; and cf. Queen's Micr. Bulletin, ii. (1885) p. 4, and iii. (1886) p. 13 (1 fig.).

‡ See this Journal, 1882 p. 21.

solution of chloride of calcium, or glycerin, was intended for comparatively low temperatures, being furnished with a special form of thermometer graduated to 150° C., and as it was somewhat expensive and liable to get out of order, he devised a second form * (fig. 67) which "can be obtained

Fig. 67.



for a nominal sum, is capable of being used with an ordinary thermometer, and is available for all temperatures within the range of that instrument."

A block of copper 6 cm. by 4 cm. by 2 cm., has an aperture 2·5 cm. in diameter passing quite through it, but closed on both sides by thin glass or mica held between thin pieces of cork by means of plates screwed down, as shown in the fig., sufficiently tightly to prevent leakage. A slightly tapering canal is drilled through the block lengthways from one end, meeting and extending a little beyond the aperture. This is for a thermometer 33 cm. long, the bulb of which passes across the aperture. The tube is graduated to 600° F.† An open tube of one piece with the rest communicates with the canal. A piece of copper 3 mm. thick brazed on the block before the aperture is drilled, extends about 15 cm. beyond the end opposite to the thermometer. The part placed on the stage is mounted on some nonconducting substance, such as a piece of well-seasoned mahogany.

The thin glasses or mica having been firmly packed in their places, and the thermometer put in position, taking care that it does not come into contact with any portion of the metal, perfumed oil is carefully poured into the open tube, until when in a horizontal position it completely fills the aperture in the block; the whole arrangement is then placed on the stage so that the aperture shall correspond with the optic axis. The object to be examined is placed on the upper thin glass.

4. *Water.*—This furnishes by far the best means of heating objects, a constant temperature being more readily maintained than with any other method. Changes of temperature can also be rapidly effected.

Dr. Polaillon ‡ suggested a flat box 1·0–1·5 cm. deep and of the same form as the stage. The upper and lower faces were of glass. There were two indiarubber tubes, one leading from a vessel of hot or cold water placed on a higher level, and the other leading into a lower vessel to catch the waste water.

Prof. Stricker's § original idea is shown in fig. 68, when the two tubes and rod at the upper side are removed. It consists of a metal box with a central perforation for light, the preparation being either placed upon a cover-glass cemented down, or so arranged that the central aperture serves as a cell. At opposite points of the box two tubes are inserted for the passage of water.

* Pharmaceutical Journal, xiii. (1882) pp. 1–4 (3 figs.), 21–2.

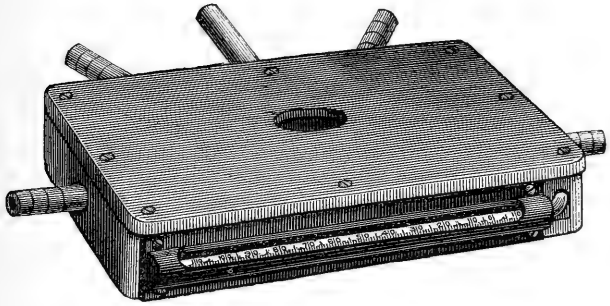
† The thermometer was described as fitted by means of a cork, but Mr. Symons found this got dry and leaked, and subsequently tried cement (sulphur and iron).

‡ Journ. de l'Anat. et Physiol., 1866, p. 133.

§ Op. cit., p. xix.

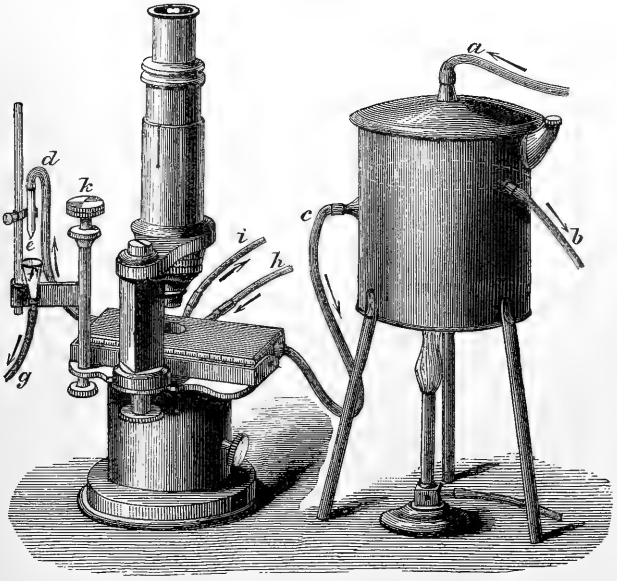
Dr. Burdon-Sanderson * modified Stricker's stage by the addition of two pipes for passing gas into the central chamber, and a rod for heating the stage by that method if desired. As modified it is shown in fig. 68, and

Fig. 68.



in use in fig. 69. In the vessel the water is maintained at a constant level, indicated by the dotted line, and at boiling temperature. *a* is the supply tube, *b* the waste tube, *c* the tube leading to the stage, and *d* a tube by which the hot water leaves the stage, terminating in a conical

Fig. 69.



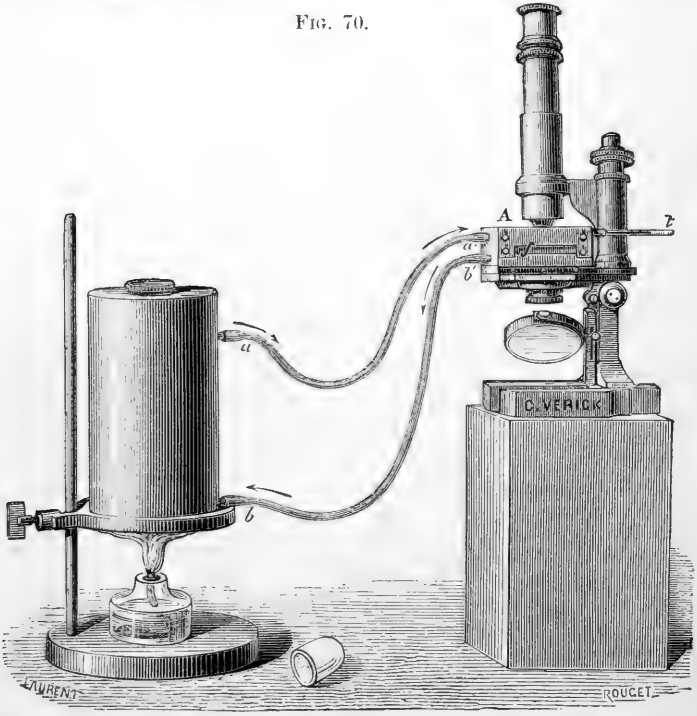
dropper *e*. A funnel *f* collects the drops which fall from *e*, and *g* is the waste. The rate of flow is determined by varying the height of *e* by means of the sliding screw on which it is supported. It admits of more exact adjustment by means of a fine screw which works in the axis of the

* Burdon-Sanderson, op. cit., pp. 15–6, fig. 3; Quart. Journ. Micr. Sci., x. (1870) pp. 366–7 (2 figs.).

vertical column on which the escape tube is supported. This column is firmly fixed in the stage of the Microscope, its axial screw terminating above in a milled head *k*. *h* and *i* are tubes for gas.*

Dr. Klein says† that in the employment of this apparatus several difficulties are encountered. For instance, the temperature of the water receptacle is only in part controlled by the regulator, and the temperature of the stage is subject to variation according to the rate at which the water flows into and escapes from it, so that unless great care is taken in the adjustment constancy cannot be relied on. Another practical difficulty lies in the fact that the temperature of the water in the receptacle is different from that in the stage, the rate of flow being so inconsiderable that there is necessarily a great loss of heat by radiation from the metal surface. If the stage is not fitted with a thermometer this difference of temperature may be determined once for all by comparative measurements, so that the true temperature of the stage can then be known at any time by deducting the ascertained loss of heat, i. e. the ascertained difference above referred to, from the temperature to which the regulator is adjusted.

Fig. 70.



Prof. Ranvier ‡ has modified the preceding apparatus as shown in figs. 70 and 71. In the centre of the stage A (fig. 70) is a horizontal slit *f*, in

* In the apparatus described in the Quart. Journ. Micr. Sci. the water was in the first instance conveyed to a loop-shaped metal tube surrounding the upper part of the objective for the purpose of keeping it warm, a vulcanite ring preventing the heating of the Microscope-tube. From the loop the water passed to the stage.

† Burdon-Sanderson, op. cit., p. 7.

‡ Ranvier, L., 'Traité technique d'Histologie,' 1875, pp. 41–2 (1 fig.)

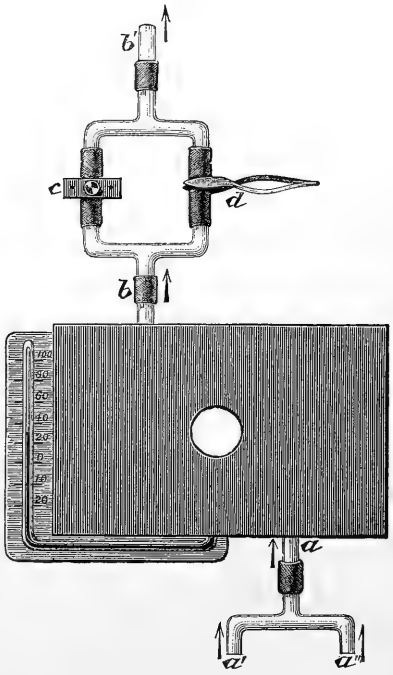
which the slide O (fig. 71) with the object can be placed. Above and below this are other vertical openings *c* and *d*, communicating with it, the upper one *d* receiving the objective, and the lower one *c* a diaphragm of glass. To prevent cooling, the space between the objective and the sides of the upper opening can be stopped with cotton wool. A thermometer *t* is inserted in a tube at one side of the apparatus, as shown in both figures.

Fig. 71.

It is essential, in order to insure the same temperature of the water in the reservoir and stage, which communicate by the circulating tubes *a a'* and *b b'*, that the stage should be above the level of the water in the vessel, and therefore that the Microscope itself should be elevated as shown in fig. 52.

Professor Ranvier describes the great advantage of the apparatus to consist in the fact that a constant temperature can be readily maintained for several hours. When the temperature of the water has been raised to 40° C., an observation can be continued for a quarter of an hour without any reheating, as the cooling proceeds so very slowly. The preparation is at the very centre of the stage, and the aperture below being closed by a glass diaphragm and that above by cotton-wool, the object is protected against all the usual causes of cooling, and its temperature is very nearly that indicated by the thermometer.*

Fig. 72.



Dr. M. Flesch † suggests a form of stage available for both high and low temperatures, and especially for rapid changes of temperature, also allowing the Abbe condenser to be used for illumination as well as the ordinary polarizing apparatus.

The author discusses some of the preceding stages, condemning Max Schultze's. He considers Ranvier's to come the nearest to fulfilling the conditions which he laid down for himself. Bartley's ‡ and Symons' § he considers to each present important advantages; the former does not, however, allow the temperature to be determined with exactness; the latter he fears would not admit of very rapid changes, and the cover-glass on which the object is placed would be liable to be broken or displaced by quick cooling.

The stage (fig. 72) is a shallow box, into which pass the tube *a* for

* To prevent the cooling of the object by the objective, especially when the focus is short, it has been suggested to place an ivory tube 30 mm. long over the objective. Dippel, tom. cit., 1882, p. 655. † Zeitschr. f Wiss. Mikr., i. (1884) pp. 33–8 (1 fig.).

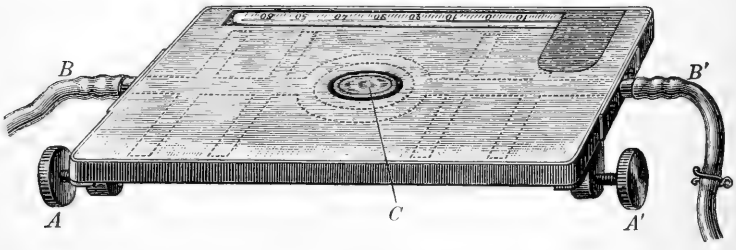
‡ See this Journal, 1881, p. 672. § See this Journal, 1882, p. 21.

introducing hot or cold water and the tube *b* for carrying it away. The former is attached to a T tube—one branch *a'* being connected with a vessel of hot water, and the other *a''* with cold water, a pinchcock closing the one not in use. A double T tube is in connection with *b*, through one branch of which the water ordinarily flows in drops controlled by the screw *c*. The object of the double tube is to facilitate an almost instantaneous change of temperature. If the pinchcock *d* on the second branch is opened at the same time as the cold-water vessel is placed in connection with the stage the water will rapidly circulate, and the stage will be filled with cold water only, so that in a few seconds the temperature may be lowered 30°.

Dr. Flesch at the time his paper was written was not wholly satisfied with his apparatus, and expected to improve it.

*Löwit's Hot Stage for High Powers.**—The thickness of the ordinary hot stage does not allow the condenser to be brought close to the under side of the slide, so that the object is not in the focus of the illuminating beam, and the use of high powers is obstructed. Dr. Löwit's hot stage (fig. 73) is intended to remedy this difficulty.

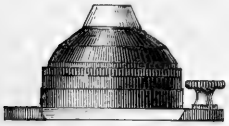
Fig. 73.



In general form the stage is like that of Stricker but thinner; the water circulates by means of the two tubes B B' and the internal tubing shown by dotted lines. The screws A A' are for centering.

Into the central opening C can be introduced the upper of the two lenses of a condenser, the upper lens, as shown in fig. 74, being much coned away, so that the top surface lies flush with the stage. The object can thus be placed in the focus of illumination, and the full effect obtained even with homogeneous-immersion lenses.

Fig. 74.



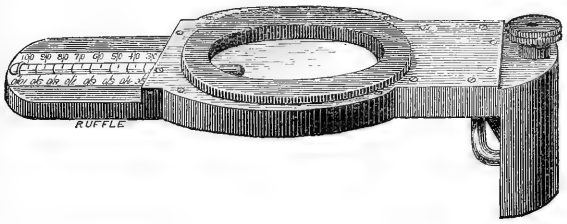
To maintain a constant temperature the author finds it better to admit the water from a vessel in which it is kept at boiling-point, and as soon as the temperature in the stage has risen to 30°–40° C. to check the flow by closing the outflow tube until the water can only issue in drops; by regulating the outflow the chamber can be maintained at any desired temperature. With a slow circulation, however, the thermometer will not indicate the temperature of the object, but only that of the water in the neighbourhood of the bulb, which will differ according to the side at which the water enters, the water of course being colder towards the exit side. Thus the thermometer might register 50° C. when the hot water enters at B' and 40° C. when it is admitted at B, so that in the

* Zeitschr f. Wiss. Mikr., ii. (1885) pp. 43–6 (1 fig.).

former case the object will be at a lower and in the latter at a higher temperature than the thermometer. If it is desired to know exactly the temperature of the object a rapid circulation must be maintained, and a thermo-regulator used.

*Dr. G. Valentin's** (fig. 75) is intended not only for heating and

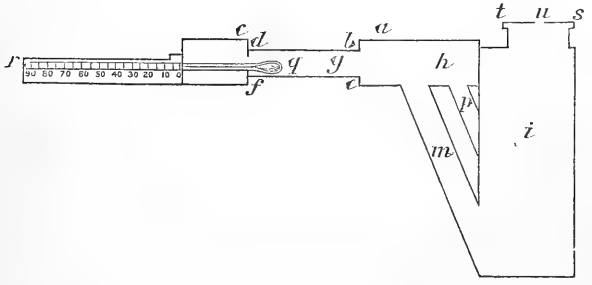
Fig. 75.



cooling by water, but also by air, and for a great variety of microscopica observations which require a closed chamber.

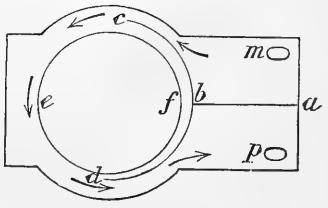
It consists of a vessel *i* (fig. 76), projecting over the side of the stage, and communicating with the chamber *h g* by the two pipes *p* and *m*. The

Fig. 76.



centre is formed of two glass discs *b d* and *e f*, *b d* being sunk below the level of *a c* to form an outer chamber, which can be closed with cover-glass when required. It is removable, so as to give access to the interior. (A section of the interior of *h g* is shown in fig. 77, where *e f* is the bottom plate of fig. 76 and *m p* the openings of the two pipes; *a b* and *c d* are two metal partitions which serve to regulate the flow of the fluid, as shown by the arrows.) A thermometer *q r* also passes into the chamber, which terminates at this end at *d f*.

Fig. 77.



To use it for heating with water the top *s t* is removed and water poured into *i* until full, and a spirit-lamp placed beneath it. The steam escapes at the small hole at *u*, or, if the water is required to boil, the top is removed and a pipe of larger opening put on. For heating with air the spirit-lamp is placed as before, or the vessel *i* is plunged in hot water.

* Valentin, G., 'Die physikalische Untersuchung der Gewebe,' 1867, pp. 421–8 (4 figs.).

If it is desired to cool the object the end of the vessel *i* can be placed in cold water, or for low temperatures in ice and salt, the chamber being then filled with pure alcohol instead of water.

The apparatus can also be used as a moist chamber or for steaming objects. In this case only a little water is placed in *i*, *u* being closed with wax and the object placed at *g*. If the glass *b d* is too thick one or other of the following plans may be adopted. The object may be placed on *b d* and covered, and a communication made between the interior (filled with water) by a piece of cotton. Or *b d* may be removed and a brass plate substituted with a square aperture, over which the object is suspended on a cover-glass.

For a dry chamber it is only necessary to introduce sulphuric acid or potash sticks into the vessel *i*.

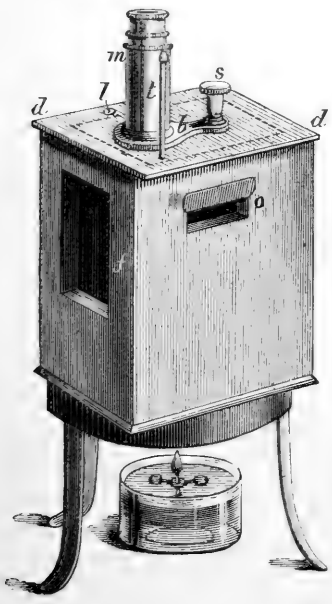
Gases can be introduced through *s t*, the object being suspended over the aperture in the brass plate as before, or the action of the vapour of ether, chloroform, &c., upon different objects may be investigated.

It is also adapted for all kinds of observations (spectroscopic, fluorescent, or otherwise) on fluids, especially where a constant thickness is required.

Prof. J. Sachs encloses the Microscope itself in a special chamber which he describes as follows:*—

"Convenient contrivances for observing the action of particular higher or lower temperatures on plants or parts of plants of considerable size are easily arranged. It is more difficult to expose microscopic objects to a particular higher or lower temperature in such a manner that it can easily and certainly be observed, and that the temperature of the object is also that indicated by the thermometer, or nearly so. All these requirements are fulfilled by the very cheap heating apparatus for the Microscope represented in fig. 78.

FIG. 78.



The size of the heating apparatus must vary with that of the Microscope; mine is constructed for one of Hartnack's ordinary instruments. The box is nearly cubical, and has double walls of sheet zinc at the bottom and sides, inclosing a space 25 mm. thick, which is filled with water through the hole *l* (fig. 78). It is quite open above, but in the front side-wall is an opening *f*, which is closed by a glass plate well fitted but not otherwise fixed. This window is sufficiently large, and is so placed that it allows enough light to fall on the mirror of the Microscope which stands in the box. The height of the box is so arranged that the upper rim of the double wall is on a level with the arm *b* of the Microscope. The opening of the box is closed by a thick cardboard cover *d d*, in which an opening is cut exactly to fit the arm *b*. By the side of the tube of the Microscope a round hole is cut in the cover through which a closely fitted small thermometer *t* passes, so that its bulb hangs

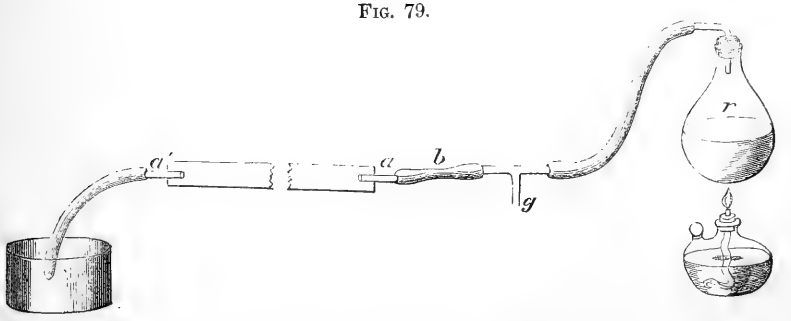
* Sachs, J., 'Text-book of Botany,' 2nd ed., 1882, pp. 735–7 (1 fig.).

near the object. The box is painted on the inside with black varnish, and a piece of cardboard moistened with water lies beneath the foot of the Microscope in order to prevent its moving and to keep the air within moist. The focus is easily adjusted to the object by means of the fine-adjustment *s* which projects above the cover; two openings in the side, one of which is shown at *o*, enable the slide bearing the object to be moved, when necessary, by a pair of forceps. It is still more convenient to fix the slide on a wire which goes through a cork fitted to the opening *o*.

It is easy by means of this heating apparatus to observe and demonstrate the influence of temperature on protoplasm-currents. To take observations at low temperatures it is sufficient to enlarge the hole *l*, in order from time to time to place pieces of ice in the cold water.*

Maintaining a constant temperature and varying the temperature.—For varying the temperature with rapidity, *Prof. Stricker* suggested† the arrangement shown in fig. 79 (centre of stage omitted). To the tube *a*, com-

Fig. 79.



municating with the stage, is attached an indiarubber tube *b*, which leads to a flask *r* for generating steam. The steam escapes through the perpendicular limb *g* of the T-shaped tube which is interposed between the flask and *b*, because it here meets with the least resistance. When this is prevented by means of a caoutchouc tube and a clip, the steam will pass through the slide and heat it. If the lamp is removed, the flask in cooling will act by way of suction on the vapour in the slide and air will enter, or iced water may sucked up through the tube *a'* and rapid cooling effected.

A preparation may also be subjected to sudden alterations of temperature by the apparatus shown in fig. 69.‡ A clip is placed on the tube *c*, leading from the water receptacle by means of which the access of the warm water to the stage may be interrupted. The end of the escape tube *d* is then allowed to dip into a vessel of cold water. This done, cold water may be readily introduced into the stage so as to cool it suddenly, by suction through the tube *c*, which must be provided with a branch (not shown in the fig.) between the clip and the stage for the purpose. To effect a sudden rise, all that is necessary is to open the clip.

An excellent contrivance for maintaining a constant temperature with a hot stage, is that devised by *Prof. E. A. Schäfer*,§ on the model of the

* Panum is also stated (Thanhoffer, tom. cit., p. 89) to have adopted the same plan as Sachs of enclosing the whole Microscope, but we have not been able to find the reference to his description.

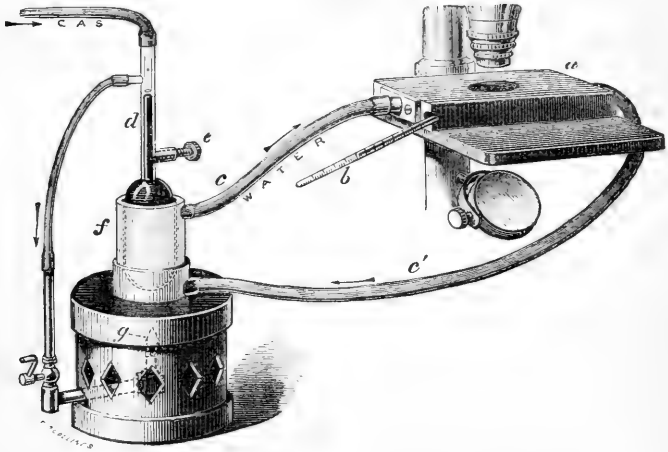
† Op. cit., pp. xx.–xxi.

‡ Burdon-Sanderson, op. cit., pp. 7–8.

§ Op. cit., pp. 22–3 (1 fig.).

ordinary gas Thermo-regulator. The object (fig. 80) is placed upon the warm stage *a*, which consists simply of a brass box resting upon the stage of the Microscope, and with a tubular aperture in the centre to admit light to the object. The box is connected by indiarubber tubes with a hollow metal jacket *f*, and the whole system thus constituted is completely filled with water previously boiled to the exclusion of air. The water is warmed at *g* by a small gas-flame and rising through the tube *c* communicates its

Fig. 80.



heat to the box *a*, the temperature of which is measured by a small thermometer *b* inserted through an obliquely placed tube quite into the central opening and immediately under the preparation. The cooled water from the stage passes down the tube *c'*, and so to the flame again, and in this way a constant circulation is kept up.

The bulbed tube *d* filled with mercury serves to regulate the flow of gas so as to keep the temperature constant at any desired point. This is effected by turning the steel screw *e* when this point, whatever it may be, is reached, so as to raise the mercury in the glass tube, and almost block up the lower end of a small steel or glass tube which is fixed into the upper end of the tube *d*. The gas used for heating passes through the small tube and then above the mercury and between the two tubes to be conducted by the side-piece to the burner below. If now the temperature rises higher in the reservoir *f* surrounding the mercury the latter will expand and rising in the tube will cut off more of the gas, and thus reduce the flame, on which the mercury will again contract and the flame increase in consequence, and so on. It is found that an equilibrium soon becomes established, and the temperature of the water and stage remains almost absolutely constant. To raise or lower the temperature all that is required is to screw *e* out or in. The smaller tube enclosed in *d* is pierced with a minute aperture to allow a constant passage of gas, so as to prevent the flame from being extinguished in the event of the mercury completely blocking up the lower end of the tube.*

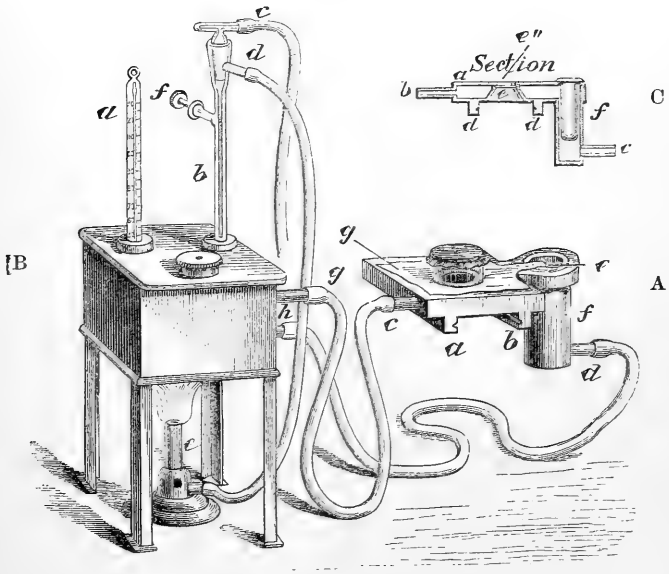
* To provide against the danger resulting from accidental extinction of the gas, Prof. Koch devised a self-acting apparatus, which, simultaneously with the extinction of the flame of the burner, shuts off the supply of gas. Cf. Crookshank's 'Practical Bacteriology,' 1886, p. 36 (1 fig.).

Dr. Dallinger's Thermostatic continuous Stage is constructed on the same principle as the preceding. It was devised for the continuous observation under high powers of the minutest living organisms, and was used by Dr. Dallinger and Dr. Drysdale for the continuous watching of monads as described in 'The Monthly Microscopical Journal,' 1869, pp. 97 *et seq.* The primary object was to arrange the field of observation, consisting of a minute drop of a septic fluid containing a given organism under observation, so that it might be observed with the highest powers, uninterruptedly, and yet that the drop of fluid should not be suffered to evaporate. The details of explanation as to how this was accomplished are given in the paper above referred to. It will suffice here to point out that the non-evaporation was accomplished by causing the objective and the covered drop to work in an air-tight chamber kept by capillary action constantly so saturated with aqueous vapour that the air within that chamber had, as it were, no room to receive the vapour from the covered drop on which observations were being made.

The present piece of apparatus aims at precisely the same thing, with the additional aim that the covered drop and all surrounding it shall be, and shall be static at, any temperature required. It was employed specially to investigate the life-history of a septic organism whose normal fluid was from 90° to 95° F.

The stage was made as described in the above paper, but it was made hollow and water-tight. The whole stage is seen in perspective in fig. 81.

Fig. 81.



At A, *a b* are two grooved pieces of solid metal which permit the stage to slide on to the stage of an ordinary Microscope and partake of the mechanical movements effected by the milled heads.

B is a vessel for water with a thermometer *a* of sufficient delicacy for indicating the temperature. *b* is a mercurial regulator, carefully made, but of the usual pattern; *c* brings the gas from the main; *d* conveys as

much of the gas as is allowed to escape from between the top of the mercury and the bottom of the gas delivery tube to the burner *e*. The regulation of this apparatus so as to obtain a static temperature, as is well known, is a matter of detail depending chiefly on the careful use of the mercurial screw-plug *f* and the height and intensity of the burner *e*. A temperature quite as accurate as is needed can be obtained for the purpose required.

The stage (A) is placed in position on the instrument; and two openings in this hollow stage at *c d* (A) are connected with two similar openings in the water-vessel, viz. *g h* (B). The whole is carefully filled with water and raised to the required temperature and regulated.

The manner in which it accomplishes the end desired is as follows. On the centre of the stage (A) will be seen a small cylinder of glass: this is ground at the end placed on the stage, and covered with a sort of drum-head of indiarubber at the upper end. By examining C with a lens it will be seen that a cell is countersunk into the upper plate of the hollow stage at *e''*, and a thin plate of glass is cemented on to this (seen also in section in the same figure). At *e* another disc of glass is cemented watertight, so that a film of warm water circulates between the upper and under surfaces of this glass aperture. A glass cup is placed in the jacketed receptacle *f* (A and C), and this also is filled with water. A piece of linen is now laid on the stage (A, *g*), with an aperture cut in its centre slightly less than the countersunk cell in which the glass disc *e''* is fixed, and a flap from it is allowed to fall over into the glass vessel *f* (A and C). Thus by capillarity the water is carried constantly over the entire face of the linen. But the glass cylinder seen in A is made of a much larger aperture than the cell and the opening in the linen, and consequently a large annulus of the linen is inclosed within the cylinder. The drop of fluid to be examined is placed on the small circular glass plate and covered with the thinnest glass, the drum-head cylinder is placed in position, the point of a high-power lens is gently forced upon the top of the indiarubber through a small aperture, thus forcing the lower ground surface of the cylinder upon the linen, and making the space within the closed cylinder practically air-tight, but still admitting of capillary action in the linen. Thus the enclosed air becomes saturated.

By complete circulation the water in the vessel *e* (A) is but slightly below that within the jacket of the stage, and thus the vapour as well as the stage are near the same thermal point.

For aiding in illumination and admitting various illuminating apparatus, a large bevelled aperture *e* (A) is made between the lower and upper plates of the stage jacket which is found to supply all the accommodation needed.

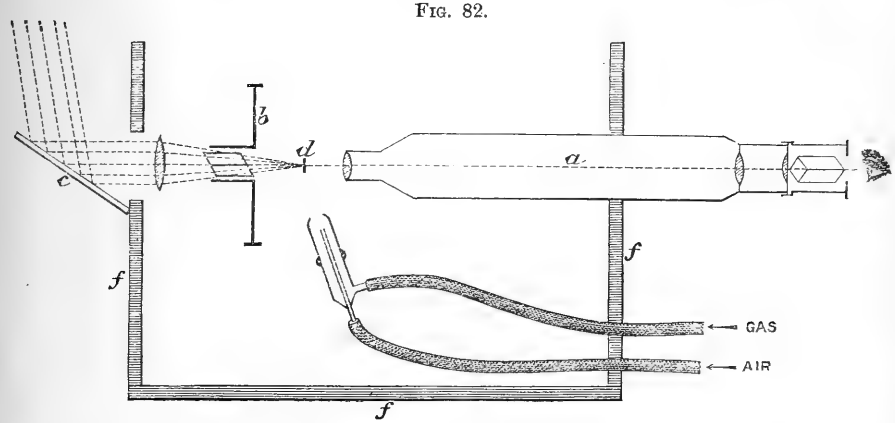
Merian's Arrangement for Heating Minerals.*—Herr A. Merian, following the researches of Mallard and Klein on the influence of heat on boracit, has studied other mimetic minerals in a similar manner. In tridymit no change of its optical relations could be perceived when the ordinary hot stage was used, and for the purpose of observing its behaviour at still higher temperatures the following arrangement was adopted.

A Microscope *a* (fig. 82) was so fixed in a box *f* that daylight could be made to pass from a plane mirror *c* through a convex lens to the nicol on the stage *b*, the Microscope being horizontal. The space between the stage and the objective was sufficiently large to allow the introduction of the preparation *d* and the heating apparatus.

* Neues Jahrb. f. Mineral., Geol., u. Palæontol., 1884, pp. 193–5 (2 figs.).

The mineral chips were supported on platinum-pointed pincers fastened to a stand, and in this way brought within the focus of a low-power

Fig. 82.



objective. By means of a small gas-jet the mineral could be brought to a white heat in a very short time, "without perceptibly warming the objective and nicol."

Capillary Tube Slide and Perforator of Cell-elements.*—One of the principal drawbacks in the microscopical examination of small objects consists in the difficulty of suitably orienting them on the slide in order to observe successively all their aspects. In observing, for instance, the segmentation of an ascidian ovum, the vitellus of which measures scarcely more than 0·1 mm., the turning round of such a delicate object demands much patience, and leads only too often to its destruction. M. L. Chabry therefore proposes the following apparatus:—

The egg is sucked into a capillary glass tube having very thin walls, and an internal diameter exactly equal to that of the egg, and measuring 8–10 cm. in length. A drop of sea-water introduced at the upper end of the tube, held vertically above the liquid, induces an internal current which drives the egg towards the middle of the tube. There is also required an ordinary slide, to which are fixed with wax two small glass sockets, at a distance sufficient to admit a cover-glass between them. These two sockets, which lie in a line following the long diameter of the slide, so exactly admit the capillary tube, that they permit no other movements than of rotation and of sliding longitudinally. That part of the tube lying between the two sockets, and containing the egg, is covered with a thin cover-glass, beneath which a drop of water is introduced. Thus submitted to microscopical examination, the object presents a clear image and its rotation is determined, even beneath the observer's eye, by the rotation imparted to the capillary tube. In order to have the latter under perfect control, one of the ends projecting over the edge of the stage is bent like the letter L.

To make it serve as a pricking, perforating, and injecting instrument, there is introduced into the capillary tube a very fine glass thread, terminated by a short, sharp point. If the end opposite that through which the stylet has been introduced be closed in such a manner as to prevent any

* Comptes Rendus Soc. Biol., iii. (1886) pp. 322–3.

escape of the liquid and of the object enclosed within the tube, the object may be pricked or perforated at any selected point by a sharp tap. If manipulated with more caution, the stylet also serves to turn the object round within the tube, and the combination of this movement with that of turning the tube permits examination in any position whatever. A lever serves to control the sliding of the stylet by reducing by five to ten times the extent of the movement imparted by the hand. This lever is a blade of straw, through the fixed end of which passes a pin fastened vertically to one of the corners of the flat slide. Its direction is perpendicular to the stylet, with which it is connected at about 1·5 cm. from its fixed end. This lever moves in the plane of the flat slide, beyond which it projects, as it is much longer than the slide is broad.

By the aid of this perforator the author has been able to pierce and kill, at will, *any* cell of an ascidian egg in segmentation, and to obtain experimentally the "monstres" called "fractions d'individu," the existence of which he discovered.

Bausch & Lomb Condenser and Substage. [*Post.*]
The Microscope, VII. (1887) p. 16 (1 fig).

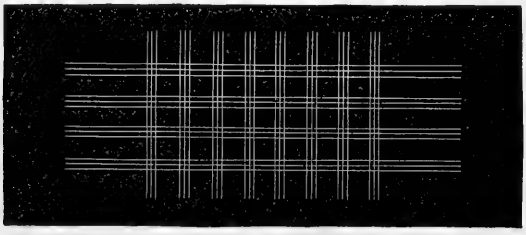
Heurck, H. van.—**Comparateur à employer dans les recherches microscopiques.** (Comparator for microscopical researches.) [*Post.*]
Bull. Soc. Belg. Micr., XIII. (1887) pp. 76–8 (2 figs.).

Rohrbeck.—**Ueber Thermostaten, Thermoregulatoren, und das Constanthalten von Temperaturen.** (On Thermostats, Thermoregulators, and the maintenance of Constant Temperatures.) *Deutsche Medicinalztg.*, 1886, and *Deutsche Chemikerztg.*, 1886.
Cf. *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 247–8.

(5) Photomicrography.

Evans's Focusing Screen for Photomicrography.*—Mr. F. H. Evans refers to the difficulty which exists in focusing, by means of an ordinary focusing lens, the microscopic image projected on a screen of patent plate glass. This is due to the power of accommodation of the eye, in consequence of which the focal plane of the image is frequently assumed to be on the outer instead of the inner surface of the screen. He suggests that this difficulty may be readily overcome by ruling on the inner surface of the glass screen (i. e. the surface towards the Microscope) a series of fine lines similar to those shown in fig. 83; the eye has then before it a definite

Fig. 83.



object in the focal plane upon which the focusing lens is adjusted, so that the almost involuntary movement of accommodation is practically arrested thereon, and the focusing of the microscopic image on that plane is thus greatly facilitated.

* Journ. and Trans. Phot. Soc., xi. (1886) pp. 25–8 (1 fig.).

BRAY, A., and R. SULZBERGER.—**La Photomicrographie.** Rapport sur la Conférence pratique de M. le Prof. Francotte. (Photomicrography. Report on the practical demonstration of Prof. Francotte.)
Bull. Soc. Belg. Micr., XIII. (1887) pp. 59–69.

FRANCOTTE, P.—**Résumé d'une Conférence sur la Microphotographie appliquée à l'histologie, l'anatomie comparée et l'embryologie.** (Summary of a lecture on photomicrography applied to histology, comparative anatomy, and embryology.)
Bull. Soc. Belg. Micr., XIII. (1886) pp. 24–56 (5 figs.).

GARRISON, F. L.—See *infra*, β (2).

HEURCK, H. VAN.—**Application du petit appareil photographique aux Microscopes continentaux.** (Application of the small photographic apparatus to Continental Microscopes.) *Bull. Soc. Belg. Micr.*, XIII. (1887) pp. 82–3.

ISRAEL, O.—**Ueber Mikrophotographie mit starken Objectivsystemen.** (On photomicrography with high powers.)
Arch. f. pathol. Anat. u. Physiol., CVI. (1886) pp. 502–14.

MERCER, A. C.—**The Indebtedness of Photography to Microscopy.**
Rep. from *Phot. Times Almanac*, New York, 1887, 7 pp.

STENGLEIN, M., and SCHULTZ-HENCKE.—**Anleitung zur Ausführung mikrophotographischer Arbeiten.** (Introduction to practical photomicrography.)
viii. and 131 pp., 5 figs. and 2 phot., 8vo, Berlin, 1887.

SULZBERGER, R.—See Bray, A.

(6) Microscopical Optics and Manipulation.

EWELL, M. D.—**Micrometric Measurements.**
[Results of measurements by six observers, showing considerable discrepancies.]
The Microscope, VII. (1887) pp. 10–2.

Glass, a New.
[Similar to the ludicrous paragraph referred to *ante*, p. 155, and contains in addition the statement that "the difference between the new and the old glass consists in the refraction of light!"]
Scientif. Enquirer, II. (1887) p. 47, from *Boston Journ. of Commerce.*

Glass, New Optical.
["The invention of a new optical glass is said to be creating a sensation in the German scientific world. The glass, owing to its great refractory power, promises to be of marked influence in practical optics, inasmuch as it will admit of the production of lenses of short focal width, such as it has hitherto been impossible to obtain. For microscopic photography it will be of the greatest importance"!]
Echo, 7th March, 1887.

H.—Measuring Refractive Index.
[G. Thompson's method. See Journal, 1886, p. 698.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 12–3.

HÖEGH, E. v.—**Eigenschaften der Jenenser Glassorten.** (Properties of the Jena glass.)
[Refractive indices and dispersive powers of forty-four kinds of glass.]
Central-Ztg. f. Optik. u. Mech., VIII. (1887) pp. 13–4.

MAYALL, J., Jun.—See Taylor, J. T.

Measurement, Minute.
[Micrometer Microscopes.] *Knowledge*, X. (1887) pp. 109–12 (3 figs.) (*contd.*)

NELSON, E. M.—**Numerical Aperture.**
[Reply to T. F. S. (p. 435), as to why an oil-immersion objective performs better than a water-immersion of the same aperture. "Accounted for by slip (loss of light by reflection, &c.) and unavoidable errors in construction."]
Engl. Mech., XLIV. (1887) p. 480.

"ORDERIC VITAL."—**Schott & Co.'s New Optical Glass.**
[Contains a translation of the list of glasses. Cf. Journal, 1886, p. 856.]
Engl. Mech., XLIV. (1887) pp. 523 and 563.

PSCHEIDL, W.—**Bestimmung der Brennweite einer Concavlinse mittels des zusammengesetzten Mikroskopes.** (Determination of the focal length of a concave lens by the compound Microscope.)
[Find the position of an object in which the given concave lens produces an image half the size of the object itself; the distance between the image and object is then equal to one-half the focal length, if the thickness of the lens be neglected.]
SB. K. Akad. Wiss. Wien, XCIV. (1886) p. 66.

Royston-Pigott, G. W.—**Microscopical Advances. XVI.**
[Ancient and modern diffraction lines.] *Engl. Mech.*, XLV. (1887) p. 1.
S., T. F.—See Nelson, E. M.
Taylor, J. T.—**Photographic Lenses.**
[Contains remarks on the new glass by the author, J. Mayall, jun., and others.]
Journ. Soc. of Arts, XXXV. (1887) pp. 192–201, 268–9.

(7) Miscellaneous.

A Visit to Jena.—At the January meeting of the Society, Mr. J. Mayall, jun., gave an account of his recent visit to Jena, where during about a fortnight he had been the guest of Prof. Abbe. Every facility had been given him for following the technical processes employed in the manufacture of Microscopes in Messrs. Zeiss's optical and mechanical workshops, and in the production of optical glass in the Jena Optical Glass Works, and his impression was that it would be hardly possible to overrate the skill in organization there displayed for the purposes in view. Messrs. Zeiss employed upwards of three hundred assistants in a series of workshops so arranged that those departments where delicate work was being produced —where the vibration of steam machinery would be a serious drawback— were quite separate from the departments where steam-power was employed.

Messrs. Zeiss had found it advantageous to make their own brass castings, and hence had established a foundry on their premises. He had seen the various heavy kinds of lathe-work and fraising in full operation with steam-power. The parts of the Microscope-stands where this and other mechanical work was being executed were usually given out in sets of ten, and in general the system of piecework was in vogue throughout the workshops. With regard to the optical work, only a very small portion was produced by the aid of steam-power; for instance, the plane surfaces of eye-piece lenses, which were worked together in large sets, and the glass-slitting by means of rapidly-revolving iron discs charged on the edges with diamond fragments. The glass-slitting machine was largely employed in the preparation of prisms of the different samples of glass for the determination of the refractive and dispersive indices. By means of the glass-slitter, the plates of optical glass, as received from the glass works, were cut to the various thicknesses required, and then, by means of ordinary American wheel-cutters, the thin strips were cut into squares of the sizes required. The squares were placed in suitable trays in the storeroom, whence they were given out to the glass-grinders, together with the necessary tools and the gauges belonging to them. The glass-grinders snipped the squares to approximately the disc shape, and then cemented them each on a suitable block, and ground and polished the surfaces, the metal tools being attached to foot-lathes with vertical spindles passing through deep horizontal trays, in which the refuse emery, &c., was caught, and the workmen were generally seated.

For testing the accuracy of the finished surfaces, Fraunhofer's method was employed, which consisted in providing for each curvature required a pair of highly-finished standard convex and concave surfaces worked in rock-crystal, of which the radii had been accurately determined by means of a spherometer of great precision, the perfection of the curvatures being shown by the symmetrical formation of Newton's rings when the surfaces were pressed in contact. Each surface, as finished, was tested by contact with the corresponding standard surface of rock-crystal, and the polishing was continued until the required degree of accuracy was reached. He was previously aware that Fraunhofer had employed this method of testing the accuracy of spherical surfaces for telescopes, using standards made of glass. Prof. Abbe informed him that Dr. Hugo Schröder had

suggested the advisability of making the standards of rock-crystal, instead of glass, for testing Microscope lenses, on the ground of its much greater durability where required to be in such constant use. Each workman was also provided with a contact-measurer, by which he was able to determine the thickness of the lenses, and thus approximate to the required thickness within a small fraction of error. An experienced foreman superintended this department, and was responsible for the accuracy of all gauges, &c. Mr. Mayall said he had been much interested to see these methods of precision in regular daily use in Messrs. Zeiss's workshops, the more so from the fact that for much of the optical work lads were employed, who thus obtained admirable training for the more difficult branches on which they entered later on. He had also witnessed the processes of centering the separate lenses, and reducing them to the required diameters; then the cementing into combinations and the mounting in metal cells, with its attendant further process of centering. He had also watched the whole process of manufacturing a front lens for an apochromatic 1/8 homogeneous-immersion, from the grinding to the complete mounting in its cell, centering, &c., the lens being somewhat greater than a hemisphere, and the figure being tested in the standard concave of rock-crystal as he had previously described. The rapidity and dexterity shown throughout the execution of this delicate work had most favourably impressed him as to the high character of the training in Messrs. Zeiss's workshop, for it should be noted that the production of such work was not confined to one pair of hands, as generally obtained in England, but was being executed by several—workmen of special aptitude, doubtless, but still such as the system of training there adopted brought to the fore in sufficient number to meet the demand, even in so large an establishment. He had also observed with special attention the methods employed for testing the finished objectives; but there, of course, so much depended on the education of the eye and judgment, that he could not venture to criticize, not having himself practised with Prof. Abbe's silvered plate method. He understood, however, from Prof. Abbe that the method enabled the director of that department to give precise instructions as to alterations needed to reach a certain standard of excellence.

He must not omit to refer to the photomicrographic department, to which Dr. Roderick Zeiss had given special attention. A separate building had been erected for this purpose, and massive concrete blocks supported the installation of the electric light, projection apparatus, &c., as free as possible from vibration. Here he had seen a number of images of test objects, &c., projected on a screen by means of an arc lamp of 1200 c.p., using various objectives, from 1 in. to 1/20 in. focus. In some instances the higher degree of achromatism attained in the new apochromatic objectives was unquestionably shown, and he had no difficulty in admitting that on the whole the projection images were the best he had ever seen by artificial light. In view, however, of the extreme difficulty—impossibility he might say—of controlling the arc lamp, of maintaining a steady and equal light even for a space of one or two minutes, he thought for purposes of photomicrography it could not be commended, especially not for producing large negatives by direct projection. He had long held the opinion that the best photomicrographs were obtained by making small negatives by direct projection, negatives just large enough to exhibit the points sought to be demonstrated; if, then, it were desirable to produce a further enlargement, the small negative could be magnified by an ordinary photographic process. In this way the best photomicrographs by Dr. Van Heurck, of Antwerp, were produced, and the most difficult results, such as photographing the

higher bands of Nobert's 19-band test plate, were obtained by using sunlight.

The main purpose of his visit to Jena, however, was to submit to Prof. Abbe's examination a number of the best English objectives, whence he could accurately estimate the standpoint of excellence from which English microscopists would criticize the new apochromatics produced at Jena. In furtherance of this purpose the President of the Society and Mr. Frank Crisp had placed at his disposal the best objectives in their collections. Mr. Nelson had also requested him to select from his fine collection any objectives which he thought would worthily represent English optical work. From these collections, and sundry examples from his own, Mr. Mayall said he believed he had been able to carry out the intention of his visit to Jena; and he thought Prof. Abbe was now as vividly aware of what was meant in England by "critically good images" as possibly could obtain under the circumstances. He must, of course, mention the fact that he took with him to Jena his large Powell and Lealand Microscope and accessory apparatus. If his visit to Jena resulted in inducing Prof. Abbe to withdraw his frequently-expressed depreciation of the value of the achromatic condenser—and he had reason to believe this would be one of the practical results following upon his visit—he (Mr. Mayall) should consider his journey not wholly fruitless in advancing practical Microscopy.

Referring to the Jena Optical Glass Works, Mr. Mayall said they were under the management of Dr. Otto Schott, who appeared to have thrown his energy thoroughly into every detail of their organization, which had so favourably impressed the German Government that large official grants of money had been made in aid of the experiments suggested by him. The aim of the series of experiments had been to arrive at a knowledge of the conditions necessary for regulating the refractive and dispersive indices as far as possible with the various known substances capable of vitrification. He understood Dr. Schott to say the experience he had gained in the experiments made with the assistance of the Government—experiments which had all been carefully classified and recorded—enabled him now to undertake to furnish any kind of optical glass according to sample supplied to him. On receiving such a sample, he proceeded to analyse it both optically and chemically, and then, from his registrations of experiments already made, he was able at once to select the elements and conditions required to arrive at the same result. Moreover, the exhaustive series of experiments he had made, enabled him, within certain limits, to control the ratio of the refraction to the dispersion, so that he had not only succeeded in increasing the range between the limits beyond what had been reached previously by makers of optical glass, but was also in a position to manufacture glass of any given refraction and dispersion for special purposes. The skilful optician was thus provided with new optical means which would certainly lead to general improvements in the construction of telescopes, field-glasses, &c. The new kinds of glass employed in Prof. Abbe's apochromatic objectives were produced at these Glass Works, as also the glass employed by Messrs. Powell and Lealand for their new apochromatics. Dr. Schott expressed his conviction that several of his new kinds of glass would be found of great importance in the construction of photographic lenses; he also said that Steinheil, the well-known optician of Munich, had already adopted its use largely. Such a fact ought not in his (Mr. Mayall's) opinion to be neglected by our makers of photographic lenses; for, assuredly, if one of them could succeed in producing lenses with a given ratio of aperture to focal length, but with a larger and flatter field than

had hitherto been seen—and the apochromatic Microscope-objectives showed how advance in that direction had been made by means of the new glass—the demand for such improved lenses would be practically unlimited.

Microscopic Justice.—Under this heading the 'Evening News' of 16th March says:—"Mr. Justice Chitty's Court presents a curious scene to-day. The judge is trying a patent case relating to waterproof fabrics. The Attorney-General, Mr. Moulton, Q.C., and Mr. Finlay, Q.C., are engaged in the case, and the learned counsel are provided with Microscopes to examine the materials. Another Microscope is placed upon the judge's desk, and during the morning witnesses have been seated beside Mr. Justice Chitty peering through the Microscope to detect differences of manufacture in the fabrics."

LOEWENHERZ, L.—**Zur Geschichte der Entwicklung der mechanischen Kunst.** (On the history of the development of mechanical art.)
[Includes G. F. Brander (Glass Micrometers) and Fraunhofer (Achromatic Lenses and Microscope).]
Zeitschr. f. Instrumentenk., VI. (1886) pp. 405–19.

MACFARLANE, J. M.—**On the Progress of Microscopical Research.**
[Presidential Address to the Microscopic Section.]
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 319–26.

MATTHIESSEN, L.—**Ueber eine neue Etagenloupe.** (On a new "tier" lens.)
[Discusses the lenses described in this Journal, 1886, p. 1065.]
Central-Ztg. f. Opt. u. Mech., VII. (1886) pp. 109–10.
See also *Nature*, XXXV. (1887) p. 331.

MAYALL, J., Jun.—**Cantor Lectures on the Microscope.**
[Reprint in a collected form of the lectures noted in Journal, 1886, p. 869.]
97 pp., 103 figs., 8vo, London, 1886.

POUCHET, C.—**Prof. C. Robin, Sa Vie et son Œuvre.** (Life and work of Prof. C. Robin, Hon. F.R.M.S.) (*Concld.*)
Journ. de l'Anat. et de la Physiol., XXII. (1886) pp. xlix.–clxxxiv.

Scientific Directory. *Sci.-Gossip*, 1887, pp. 40, 65.

Western Microscopical Club.
[Report of meeting on 7th February, 1887, with system of classification of Mr. Crisp's Collection of Microscopes, &c.]
Engl. Mech., XLIV. (1887) p. 539.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

ESMARCH, E.—**Ueber die Reincultur eines Spirillum.** (On the pure culture of a *Spirillum*.) [*Post.*] *Centralbl. f. Bacteriol. u. Parasitenk.*, I. (1887) pp. 225–30.

PETRI, R. J.—**Eine kleine Modification des Koch'schen Plattenverfahrens.** (A small modification of the Koch plate process.) [*Post.*]
Centralbl. f. Bacteriol. u. Parasitenk., I. (1887) pp. 279–80.

SMITH, T.—**The relative value of cultures in liquid and solid media in the diagnosis of bacteria.** *Med. News*, 1886, II. pp. 571–3.

(2) Preparing Objects.

Preparing Goblet-cells.†—Dr. J. H. List examines goblet-cells, if possible, in aqueous humour, iodized serum, and 0·5 per cent. salt solution.

As isolation media, excellent results were obtained from Müller's fluid after acting for several weeks, from 0·5 per cent. osmic acid in 24 hours, followed by teasing out in distilled water or dilute glycerin (equal volumes of glycerin and distilled water), and from 0·1 per cent. chromic acid in

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. f. Mikr. Anat., xxvii. (1886) pp. 481–588 (6 pls.).

one or two weeks. He also used one-third alcohol for 24 hours, followed by staining with rosanilin nitrate or dilute Renaut's hæmatoxylin-glycerin, to show the granular circle round the nucleolus of the goblet-cell nuclei in the bladder of various amphibia. The best results were obtained from sections. The objects were either placed for some days in Müller's fluid and then hardened successively in 50, 70, 90, and 100 per cent. alcohol, or were left in 0·5 per cent. osmic acid for 24 hours and then hardened gradually in spirit. But excellent results were also given by 2 to 3 days' hardening in 0·25 per cent. chromic acid, followed by washing in water for 24 hours, and this by gradual hardening in spirit, or by a 24 hours' action of Flemming's chrom-osmium-acetic acid, and after hardening in spirit. The objects were imbedded in celloidin, then cut and stained in the manner previously described,* although it may be mentioned that rosanilin nitrate and Weigert's Bismarck brown are excellent for the purpose. The sections were overstained, and the excess of colouring matter extracted in absolute alcohol, and then after dehydration and clearing up in bergamot oil, were mounted in balsam or dilute glycerin. For the connections between the goblet-cells and nerve-terminations, a 0·5 per cent. gold chloride solution was used after Ranvier's method.

Preventing Cartilage-cells shrinking away from Matrix.†—Mr. B. L. Oviatt states that Prof. Gage finds that the following mixture is superior to the saturated solution of picric acid, recommended by Ranvier for preventing cells shrinking away from the matrix: Picric acid, 7·5 grns.; alcohol (95 per cent.), 250 c.c.; water, 250 c.c. After 24 hours the sections are transferred to water, wherein they remain for 6 to 12 hours.

Demonstrating the Nuclei of Mammary Gland-cells in Lactation.‡—Dr. F. Nissen used as his material the glands of suckling bitches, rabbits, and cats. The animals having been killed by cutting their throats, the glands were quickly removed and cut into small pieces, some of which were placed in a concentrated sublimate solution heated to 40° C., and others in Flemming's chrom-osmic-acetic acid mixture. After twelve hours the pieces from the sublimate solution were washed in flowing water for twenty-four hours, and then hardened in alcohol. When sufficiently hard they were passed for twenty-four hours into a one per cent. watery solution of logwood, and thereupon for another twenty-four hours into a one per cent. alum solution (changed five or six times). In order to obtain a pure nuclear stain, the colour must be extracted with the alum solution until the extraction fluid is but little tinged. The protoplasm is either unstained or has merely a faint bluish reflex, the chromatin of the nucleus alone is stained; the connective tissue is unaltered, but the lymph corpuscles are deeply dyed, so that by the degree of stain they are easily discriminated from the nuclei of the alveolar epithelium. The coloured pieces were dehydrated with absolute alcohol saturated with turpentine oil, imbedded in paraffin and cut with a microtome. The pieces kept in Flemming's mixture were after two or three days washed for twenty-four hours, hardened in absolute alcohol, and imbedded unstained in paraffin. The sections were freed from paraffin by means of turpentine, and the turpentine removed by alcohol.

Gram's method was used for staining. The staining fluid is a solution of 3 grms. anilin, 1 grm. gentian violet, in 15 absolute alcohol, with addition of 100 grms. of aq. dest. When removed from alcohol the sections are

* See this Journal, 1885, p. 902.
† St. Louis Med. and Surg. Journ., li. (1886) p. 209.
‡ Arch. f. Mikr. Anat., xxvi. (1886) pp. 337–42 (1 pl.).

placed from 3–5 minutes in this solution, then washed for a few seconds in absolute alcohol, and then transferred to the iodide solution, which is—1 part iodine, 2 parts iodide of potassium, and 300 parts water. They are finally decolourized in absolute alcohol, cleared up in oil of cloves, and mounted in Canada balsam.

Artificial Distortions of the Nucleus.*—Dr. C. Van Bambeke employed principally the intestinal canal and Malpighian vessels of Arthropoda in his researches. The organs or their parts taken from the living animal were teased or spread out. Organs of tubular form, like the intestinal canal, were first of all split up and their contents evacuated. The blood of the animals could be examined without the aid of reagents; yet it was more advantageous to add a fixative and a staining medium. The author preferred acid methyl-green, under the influence of which reagent the nuclei of the eyes and their alterations could be easily studied. For permanent preparations, fixation with osmic acid, staining with methyl-green, and mounting in dilute glycerin were employed.

The manipulation to which the organs were exposed produced alterations in a large number of nuclei, and this alteration occurred also in various proportions, according to the species examined.

Demonstration of the Fibrillæ of Unstriated Muscular Fibres.†—For demonstrating the longitudinal fibrillation of unstriated muscular fibres the following method has proved very satisfactory according to Prof. S. H. Gage: Ten to fifteen cm. of perfectly fresh small intestine from a cat or other animal is tied at one end, and into the other is injected the following mixture: 95 per cent. alcohol 25 c.c., water 75 c.c., picric acid crystals 3/4 gram. When the intestine is moderately distended, the end in which the injection is made is tied, and the piece of intestine placed in a glass dish and covered with the mixture. After one or two days the muscular coats may be torn off in shreds. If one of the shreds is teased well with needles, unstriated muscular fibres may be partly or wholly isolated. They may be mounted in 75 per cent. glycerin. The picric acid stains the fibres yellow, and with a homogeneous-immersion (1/12 or 1/18) the longitudinal fibrillation shows with the greatest clearness. In some cases the ends of the fibres will be frayed, and show the fibrillæ something like a brush.

Preparation of the Organs of the Nervous System.‡—Prof. G. Golgi's improved method is as follows:—

1. Combined use of bichromate of potash and nitrate of silver. This depends on the gradual removal of the bichromate from the hardened pieces by means of a half to 1 per cent. solution of silver nitrate. The reaction is completed in 20 to 30 hours. This method is somewhat uncertain. 2. Successive use of bichromate of potash, osmic acid, and silver nitrate. Hardening is effected in a mixture of a 2 per cent. solution of bichromate, 8 parts, and 1 per cent. solution of osmic acid, 1 part. The pieces, which must be very small, are then immersed in the silver nitrate solution. 3. Successive action of potassium bichromate and perchloride of mercury. This method requires from one month to a year (according to the size of the pieces) for its full development, but a whole brain may be stained through at once.

Preparation of Amphibian Embryos.§—Dr. C. Rabl recommends that the embryos of *Salamandra maculosa* and *atra* and *Triton tæniatus* should

* Arch. de Biol., vii. (1886) 3 pls. † The Microscope, vi. (1886) pp. 267–8.
‡ Milano, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 409–10.
§ Morphol. Jahrb., xii. (1886) pp. 252–7 (2 pls. and 2 figs.).

be fixed in 1/4 to 1/3 per cent. platinum chloride solution for from 3 to 24 hours, according to size. Then, having been carefully washed in water, they should be transferred to weak spirit and afterwards to stronger alcohols. Sections should be stained on the slide.

Preparation of Eggs of Osseous Fishes.*—Dr. M. v. Kowalewsky hardens eggs of *Carassius auratus* L., *Polycanthus viridiauratus* L., and *C. auratus* L. var. for 1¼ hours in a mixture of picro-sulphuric acid 8 vols., 1 per cent. chromic acid 1 vol. The eggs of *Carassius* were placed in the foregoing along with the pieces of plants to which they adhered, because they could not be separated therefrom without damage. The hardened eggs were then transferred to 20 per cent. spirit, frequently changed, for about 12 hours, and then in the course of 10 hours passed through 20, 28, 35, 43, 50, 60, and 70 per cent. spirit, in the last of which they were preserved. Before staining, the egg-sac was ruptured under a dissecting Microscope. The stain was either Grenacher's borax-carmine, or hæmatoxylin, then toluol and paraffin.

Preparation of Heart-muscle in Cardium edule.†—Dr. K. Drost used the following maceration medium introduced by Möbius:—Chromic acid 0·25 per cent., osmic acid 0·1 per cent., acetic acid 0·1 per cent., in sea water. In this fluid the objects remained for some days; acids by themselves gave no results.

For *Montacuta bidentata* 1 part sea-water to 0·5 per cent. bichromate of potash 4 or 6 parts were used; but the hairs of the sense-organs were found to be macerated.

Preparation of Eggs of Arthropoda.‡—Dr. F. Stuhlman in the examination of the eggs of insects, spiders, Myriopods, and *Peripatus*, examined fresh objects in 0·75 per cent. salt solution, to which is sometimes added weak acetic and methyl-green acetic acid. The foregoing was only suitable for young eggs, as older ones are too opaque. As fixative, cold concentrated sublimate solution proved the best. Water, 33 per cent. alcohol, and hot sublimate solution were not so useful. The cold sublimate fixed in 5 to 10 minutes. The preparations are then thoroughly washed; a few drops of tincture of iodine hastened the process. Then 60 per cent. spirit and finally absolute alcohol. The chorion is perforated with a fine needle, but the upper-pole is to be avoided. Ovaries are placed for several hours in chloroform, then from one to three days (according to size) in paraffin at about 55° C. The imbedding mass is rapidly cooled. The sections are stuck on with a thin layer of Mayer's fluid. The author states that fresh albumen mass stains less easily than the older. The stains used were Grenacher's borax-carmin, Weigert and Ranvier's picrocarmin, and Flemming's hæmatoxylin. The author recommends double staining with picrocarmin and hæmatoxylin; weak staining first with picrocarmin and afterwards with the logwood. The dye is then extracted with acidulated alcohol until a red hue appears, the sections are then transferred to ammoniacal alcohol until the blue colour reappears. In order to obtain various shades of colour the author advises to stain about 3/4 of the sections (*sic*) with picrocarmin and then to draw out the slides from the fluid so that the upper part is more deeply stained than the lower. The slide is then turned round and the process reversed with hæmatoxylin. Afterwards absolute alcohol, bergamot oil, xylol balsam,

* Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 434–80 (1 pl.).
† Morphol. Jahrb., xii. (1886) pp. 163–201 (1 pl.).
‡ Ber. Naturf. Gesell. Freiburg i. B., i. (1886).

Flemming's chrom-osmium-acetic acid, and safranin staining give good results. Fixation with 3 per cent. nitric acid produced vacuoles in the yolk, and was, therefore, of but little use.

Preparation of the Embryo of the Fresh-water Crayfish.*—Dr. H. Reichenbach hardens the eggs by placing them in water, which is gradually heated up to 60° or 70° C. (rupture of the chorion does not damage the embryo); they are then hardened in a 1 to 2 per cent. bichromate or 0·5 per cent. chromic acid for 24 hours; next washed for a similar period, and then transferred first to 70 per cent. spirit and lastly to absolute alcohol. The chorion is then opened, and the embryo separated from the yolk by means of a sharp knife, and stained with picrocarmin. The yolk stains yellow, the plasma and nuclei red; then water, alcohol, cloves, and balsam.

Preparation of Copepoda.†—Dr. J. Vosseler recommends as the simplest method for killing, hardening, and staining Copepoda, to place them for about 12 hours in a mixture of Flemming's solution 1 part, water 2 parts, and then, after washing, to harden in spirit; mount in Venice turpentine. The animals also may be killed by the gradual addition of alcohol to the water in which they are contained. After having been placed in a mixture of equal parts of glycerin and water from 10 to 14 days they may be examined. Permanent preparations should be afterwards placed in absolute alcohol and mounted in Venice turpentine.

Preparation of Lumbricida.‡—Dr. H. Ude, in order to demonstrate the anatomy of the pores and the histology of the body-wall, employed the following methods:—

1. Living earthworms were placed in 0·5 per cent. chromic acid and hardened therein for eight to ten hours, washed in water, and transferred to 70 per cent. alcohol, then stained with Hamann's neutral acetic carmine, 70, 80, 90, 100 per cent. spirit, chloroform, chloroform-paraffin, pure paraffin. Results: Hypodermis good; longitudinal muscles destroyed.

2. The worms were killed in boiling water and the bodies, stretched on cork, were then treated for eight hours with 1 part concentrated picro-sulphuric acid to 3 parts distilled water. After washing they were stained with Grenacher's borax-carmine. Results excellent, but if the colour be withdrawn with hydrochloric acid alcohol the cuticula and hypodermis are damaged.

3. If the animals are to be preserved in spirit they are previously narcotized with chloroform vapour, in order to prevent too great contraction. Stain with borax-carmine.

Preparation of Rhabdocœlous Turbellaria.§—Dr. M. Braun prepares whole specimens on a slide by running under the cover-glass a mixture of 3 parts Lang's fluid and 1 part of a 1 per cent. osmic acid solution. Directly the animals become opaque the superfluous fluid is removed with blotting-paper, and then replaced by 45 per cent. spirit and afterwards by 70 per cent. alcohol. The cover-glass is then removed, and 96 per cent. alcohol applied. In a few minutes the latter is replaced by 1 or 2 drops of alum-carmine which stains in 2 or 3 minutes. Wash in water, transfer to alcohols of gradually increased strength up to absolute; clear up in oil of cloves or creosote, and mount in balsam.

* Abh. Senckenb. Naturf. Gesell., xiv. (1886) 137 pp., 14 pls.
† Inaug.-Diss. Stuttgart, 1886. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 400.
‡ Zeitschr. f. Wiss. Zool., xliii. (1886) pp. 87–143 (1 pl.).
§ Arch. Naturk. Liv.-Esth. u. Kurlands, x. (1885). Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 398–9.

If the animals are to be sectioned the author uses Lang's fluid boiling, or the before-mentioned mixture of Lang's fluid and osmic acid. After 5 minutes the fixative is removed, the object washed with water and treated with alcohol. In two days the staining may be done. Imbedding is made in a mixture of ordinary paraffin, tallow, and hard paraffin (about 1/10 of the mass). The latter imparts a consistence suitable for riband sections.

Preparing Diatoms in Cementstein.*—Mr. H. Morland recommends the following plan for preparing and isolating the diatoms in Jutland "cementstein":—

Slices about 1/25 in. in diameter are first of all prepared with "Wellington knife-powder." When the slice is finished on one side, it is attached with balsam, prepared slide downwards, to the slip on which it is finally mounted. The balsam for this purpose must be hard, and it is necessary to avoid bubbles under the section. The slices are fixed with balsam slightly hardened, and then hardened off gradually by placing the slips in a very cool oven for a week or ten days; the balsam is thus hardened throughout without bubbles. The second side of the slice can now be rubbed down in the same way as the first side with "Wellington knife-powder" and water on glass. As the section approaches completion, care and very light pressure must be employed, the grinding being continued until the section begins to break away at its edges. The slip with section attached is now washed with clean water, wiped, and dried off with a very gentle heat, not sufficient to soften the balsam. A very small quantity of balsam is now put on the section, the cover placed on, and pressed down hard. The slide is now placed in a cool oven for a few days. A ring of Bell's cement will enable it to be examined under an oil-immersion lens without fear of the oil attacking and softening the balsam.

In order to isolate the diatom sections, after preparing one side of the slice, it is attached to a piece of glass about $1\frac{1}{4}$ in. by 1 in. instead of the ordinary 3 in. by 1 in. It is then immersed, still attached to the glass, in benzol. After about half an hour it can be brushed off with a camel's-hair pencil on to a glass slip, and cleaned of all balsam by brushing with the camel's-hair pencil dipped in benzol. The slide is then transferred to methylated spirit to get rid of the residue of benzol, and, after a short time, to clean water in a watchglass. The water is poured off and a few drops of hydrochloric acid added, which at once separates the diatoms contained in the section. The watchglass is now filled up with distilled or filtered rain-water, allowed to settle, the liquid drawn off closely by means of a fine pipette, and filled up with water again; the process being repeated until the whole of the hydrochloric acid has been got rid of. The diatoms in the watchglass are now boiled in sulphuric acid; and after washing away the acid, the clean diatom sections are ready for selecting and mounting. Mr. Morland states that some of his sections prepared in this way are not more than 1/3000 in. thick.

Preparing Tubercle Bacilli.†—Herr Biedert dilutes 1 tablespoonful of sputum with 2 of water and 15 drops liquor sodæ, and then boils to fluidity; 4 spoonfuls of water are again added, and the fluid reboiled until it is of uniform density. If on cooling it does not run well, more water is added; the fluid is kept bottled for two days, and then the supernatant liquid poured off so as to leave a quantity 5–8 mm. high in the flask. To this some fresh egg-albumen is added, and after having been well shaken together the fluid is used for cover-glass preparations.

This method was found to give considerable increase to the number of

* Journ. Quek. Micr. Club, ii. (1886) pp. 299–301.

† Berliner Klin. Wochenschrift, 1886, Nos. 42–3.

bacilli over those found in the original sputum. The Ehrlich and the Neelsen-Johne methods of staining were used.

If the alkalized fluid were allowed to stand longer than two days, and if more than fifteen drops of caustic soda were added, the number of bacilli diminished. From these facts, it is naturally concluded that the non-staining is due to the alkali, and the author recommends for his procedure the Neelsen-Johne method, as he found that Ehrlich's stain was less reliable. The foregoing method is inapplicable for the demonstration of *Bacillus tuberculosis* in tissues.

BRYAN, G. H.—**On mounting selected Diatomaceæ.**
Scientif. Enquirer, II. (1887) pp. 48–50.

CERTES.—**Procédé de M. Tempère pour le montage dans le baume des organismes microscopiques délicats et pour fixer directement des Infusoires par certaines couleurs d'aniline.** (Tempère's process for mounting in balsam delicate microscopic organisms and for immediately fixing Infusoria by certain anilin colours.) [*Post.*]
Bull. Soc. Zool. France, XI. (1886) pp. xix.–xx.

Fraenkel, E., and Simmonds, M.—**Preparing Sections containing Typhoid Bacillus.**
Scientif. Enquirer, II. (1887) p. 32. *Transl.* from 'Die Ætiologische Bedeutung des Typhus Bacillus,' Hamburg and Leipzig, 1886.

GAGE, S. H.—**Notes on Microscopical Methods.**
iv. and 32 and 4 pp., 11 and 2 figs., 8vo, Ithaca, N.Y., 1886–7.

GARRISON, F. L.—**The Microscopic Structure of Iron and Steel.**
[Methods used in preparing the specimens. Microscopes. Use of photography.]
Journ. Franklin Institute, CXXIII. (1887) pp. 181–95 (2 pls. and 1 fig.).

GOODALE, G. L.—**A Method for subjecting living Protoplasm to the action of different liquids.** [*Post.*]
Amer. Journ. Sci., XXXIII. (1887) pp. 144–5.

L[ATHAM], V. A.—**Preparation of Diatoms.**
[Prof. Brun's process.] *Scientif. Enquirer*, II. (1887) p. 31.

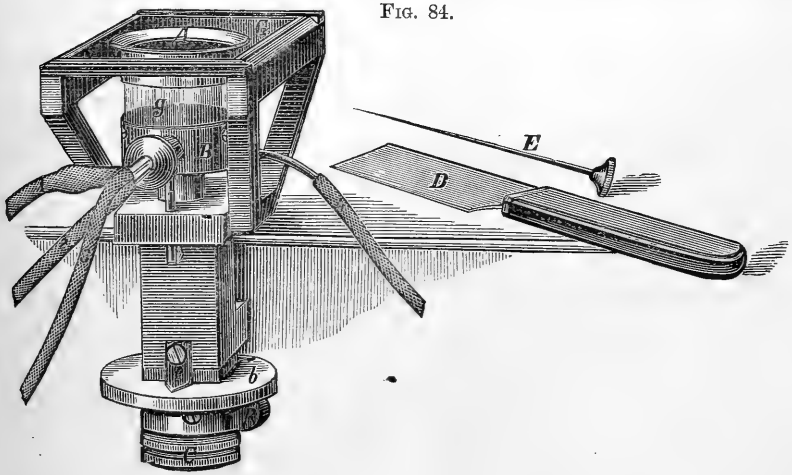
MOORE, A. Y.—**Mounting whole Insects.** *The Microscope*, VII. (1887) pp. 13–5.

SCHULZE, F. E.—**Ueber die Mittel welche zur Lähmung von Tieren dienen können, um dieselben im erschlafften ausgedehnten Zustande erhärten oder anderweitig konservieren zu können.** (On the means of paralysing animals in order to harden or otherwise preserve them in a relaxed and extended condition.) [*Post.*]
Biol. Centralbl. VI. (1887) pp. 760–4 (*Ber.* 59 *Versamml. Deutsch. Naturf. u. Aerzte*, Berlin, 1886).

(3) Cutting, including Imbedding and Microtomes.

Jung's Freezing Microtome.—This instrument (figs. 84 and 85) is constructed on the lines of the apparatus devised by Hughes and Lewis.

FIG. 84.

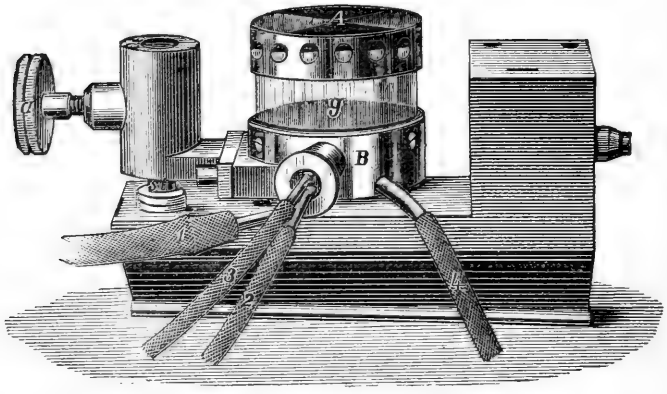


z 2

By making the tube *g* of mica, the object is found to retain the cold much longer than is the case with other constructions. A is the plate on which the preparation is laid; *g*, the mica cylinder; B, the lower part in which the ether spray tubes are fixed. No. 1 tube is from the bellows; No. 2 takes the air to the ether bottle; No. 3, the ether bottle spray point; and No. 4 is the overflow pipe for the excess ether.

The glass plate G serves as a support for the knife; *b* is divided in order to determine the thickness of the sections (1 division = 1/200 mm.);

Fig. 85.



C is the micrometer-screw which raises the object; R is the screw which fastens the instrument to the table; D is the ordinary form of knife, and E a stilet for clearing the spray points without enlarging their openings.

Fig. 85 shows a similar contrivance adapted for use with a slide microtome.

Jung's Sliding Microtome for very large objects.—As this microtome of Herr R. Jung (fig. 86) corresponds in the construction and use to the smaller instruments, it is only necessary to describe the provision for cutting large objects.

The knife is to be placed considerably higher in front than behind, in order to lessen the pressure on the objects. In order to satisfy all demands, the knife-rest is adjustable. The knife is so arranged that the whole length of blade can be used, and then the screw *c* is fairly tightly screwed down. As strong knives, even of a length of 36 cm., easily give, a knife-support has been constructed; this is fastened by the screw *c'* to the carrier. The support is arranged parallel with the back of the knife M; if the extremity *n* be slightly pressed backwards so that it touches the knife, it is then fixed in this position by the screw *o* (scarcely evident in the illustration).

This done, the spirit-vessel *Sp* can be arranged in a position which will not interfere with the free movement of the knife. In order that a stream of spirit may follow the knife over the object, the following arrangement is adopted. The spirit-vessel *Sp* turns round an axis on the column *h*; to it is joined the arm L, which carries in front the fine tube *r* (connected with *t t'*), and also the rod *p*; the latter is movable perpendicularly, and to its lower end a bridge or grip with two small rollers *i* and *i'* is fastened. The rod *p* is so placed that on each side of the metal strip *b*, screwed on to the

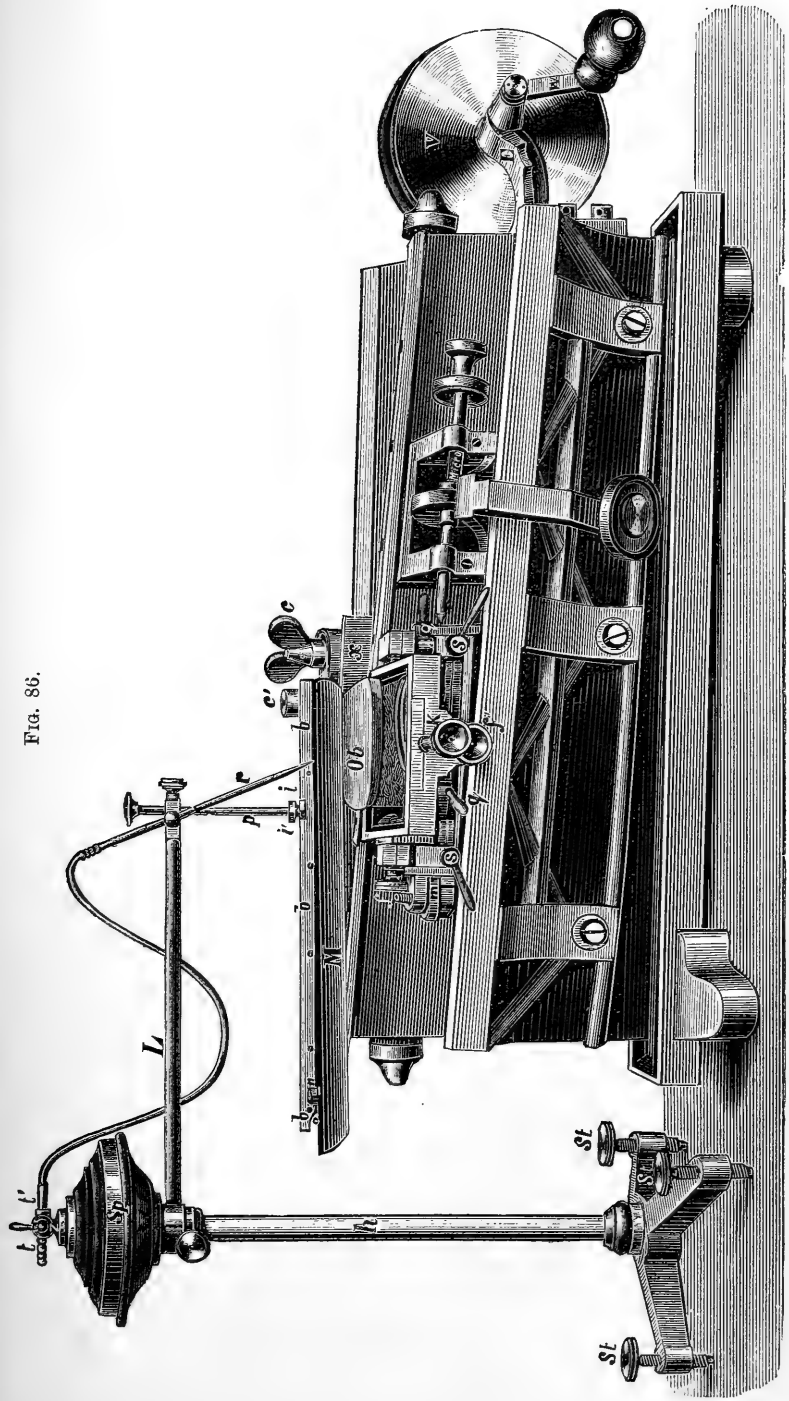


FIG. 86.

JUNG'S SLIDING MICROTOME FOR VERY LARGE OBJECTS

knife-support, there is one of the rollers. By the adjusting-screws *St* the whole apparatus is so arranged that, when the knife-carrier is in motion, no other friction occurs than that of the rollers on the strip *b b b*.

The vessel is filled by screwing off the head Z. As the tube *r* acts as a siphon, it is necessary when the cock is turned on to blow down the tube. The stream of spirit should be directed at a right angle to the knife, and about the middle of the object. This done, the object *Ob* by means of the screw *k* is firmly grasped in the fangs of the object-carrier; the correct direction for the position of the knife is given to its surface by the screws at *f* and f_1, and then the axes of the fangs are tightened up by the levers *q* and *q'*. If the height of the object is not quite correct, adjustment is made by the screw *m*. By turning the screws *s s* the holder is fixed.

V is a wheel with cranked axle *Ew*, and this by means of a catgut band moves the knife.

Microtome used at the Naples Zoological Station.—This instrument in its improved form (figs. 87, 88, and 89), is described by Herr R. Jung.*

(1) *The knife and its carrier.*—The knife, which is plano-concave, is pushed into its holder *a* (fig. 88), and fixed by means of the two screws *b* at both points. The holder is in its turn fastened to the carrier by means of two bolts *c*, and these are screwed up by inserting the rod *d* in one of the five holes (cf. fig. 87). If the knife is to rest on the carrier directly, the shorter bolt is used; if, on the contrary, the object to be cut is very long, it becomes necessary to raise the knife, and one, two, or three metal plates having been placed underneath, the long bolt is used. The choice of the screw depends on the form of the object and the position of the knife. The latter, in virtue of the construction of the holder, can be used in any position, and along its whole length. For large objects of unequal texture, it is recommended to place the knife as far as possible in an almost parallel position (cf. fig. 88), and to move the carrier slowly and carefully. In this way such objects are cut to the best advantage. If, however, the object be small and of similar consistence throughout, the knife may be placed in front and the section made by a planing motion. The paraffin block which incloses the object must be so arranged that the anterior and posterior edges of the section are parallel, and also at right angles to the middle vertical plate of the instrument; in this way, with quick planing, the sections stick together, forming large bands.

Before the knife is sharpened or stropped it is fastened to the handle, and a steel case is pushed up over its back and screwed up. In most instances one turn on a good strop suffices, and this should be done without any force.

(2) *The section-stretcher.*—In its new form this can be used for any position of the knife, and is easily applied thereto. The long rod *e* (fig. 88), partly with the hand, partly by means of the two screws *f*, is accurately adapted, parallel to the surface, and in such a way that it projects over the edge; it is then lowered by the front screw *g*, until almost in contact with the knife-surface. For small objects the slender, for large, the thick rod is used. If the sections are very bulky, the tendency to turn up must be prevented by pressing lightly on the section with a spatula, &c., as it appears between the rod and the blade. If the section-stretcher be properly arranged it works perfectly trustworthily, provided the sections have no tendency to crumble. When the knife is placed obliquely, the paraffin block is best shaped as a right-angled triangle, so disposed that the knife-

* Preis-Verzeichniss, 1886, pp. 16–9 (3 figs.).

FIG. 87.

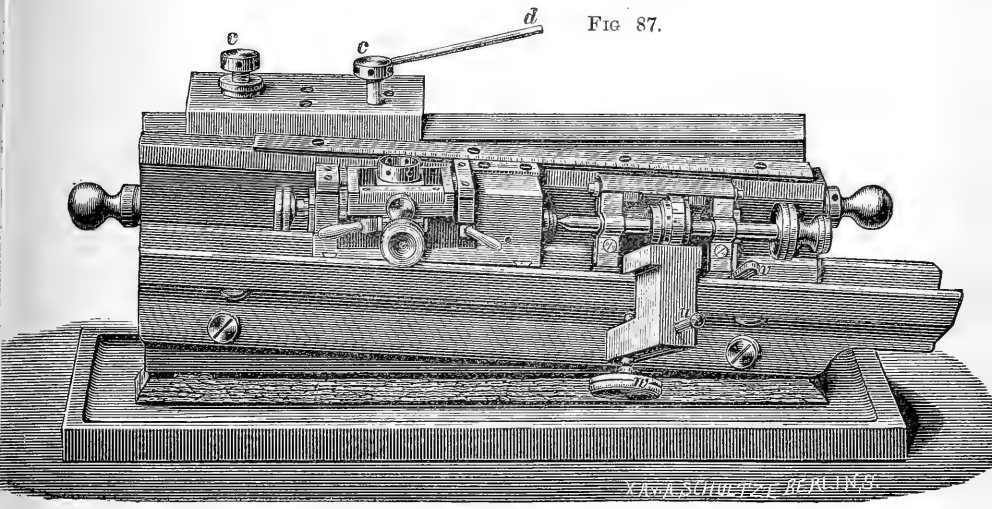


FIG. 88.

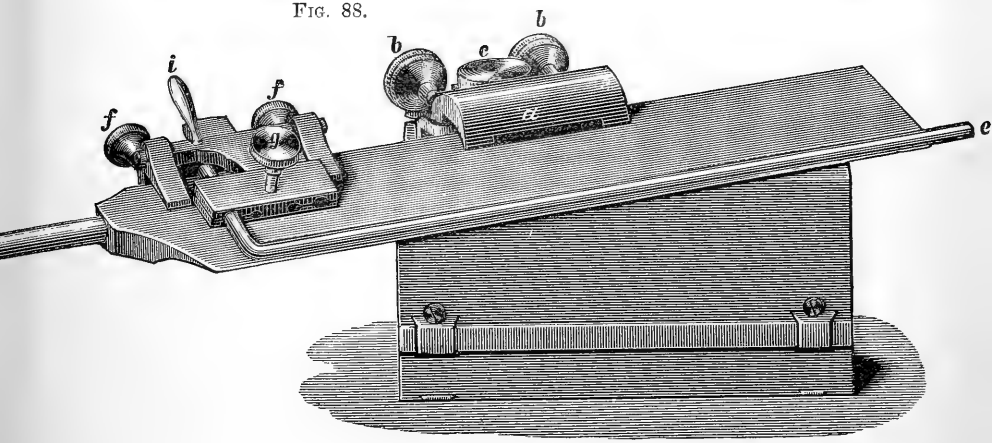
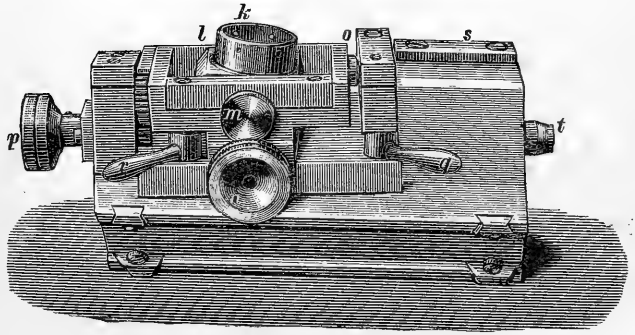


FIG. 89.



MICROTOME USED AT THE NAPLES ZOOLOGICAL STATION.

blade touches upon one of the two tangential sides and finally reaches the opposing angle. When the knife is placed across or in front the section-stretcher is usually superfluous, and the block must have the shape given above (under No. 1). The handle *i* serves to remove the rod for cleaning it or the knife-surface.

(3) *The object-carrier.*—The hollow cylinder (*k*, fig. 89) serves for the reception of the object to be cut. For this purpose it is filled with hard paraffin; in this last the paraffin block, in which the object is imbedded in the usual way, is melted with hot needles. The cylinder, by the aid of the small pin *u* (fig. 87), which fits the holes, is capable of vertical and horizontal movement, and is fixed by means of the screw *m*; by the milled head *n* the direction may be altered to the extent of 90°, and the metal frame can receive through the milled head *n* a similar inclination to the plane standing vertically to it. In this way the object may be placed in any desired direction to the knife-edge. The two levers *q* and *r* serve to fix it. Too strong pressure should be avoided, as the plates may be bent thereby.

(4) *The micrometer-screw.*—The object-carrier can be moved along by the hand, and for the accurate estimation of the amount of movement there is a vernier which corresponds with the millimetre scale on the vertical upright of the microtome. It is, however, safer to use the micrometer-screw (fig. 87) the point of which works against an agate. The screw is so threaded that one turn moves the carrier up 0·3 mm., consequently an upward movement of 1:20 produces an ascent of the object of about 0·015 mm. The screw-head is divided into fifteen parts, and therefore the interspace between any two divisions corresponds to an elevation of 0·001 mm. If by means of the pin *u* the movable half of the cylinder be shifted so that the numbers V, X, XV can be read, a click, produced by a spring, will be heard fifteen times at every revolution of the screw. If the two numbers 3 on the side of the cylinder be approximated, the clicking only occurs thrice; therefore each one corresponds to a raising of the object 0·005 mm. Similarly for 2 and 2 or 1 and 1, the values 0·0075 and 0·015 mm. are obtained. The spring-catch arrangement may be dispensed with by raising the handle *v*. The screw-carrier is fixed to the groove by the milled-head *w*.

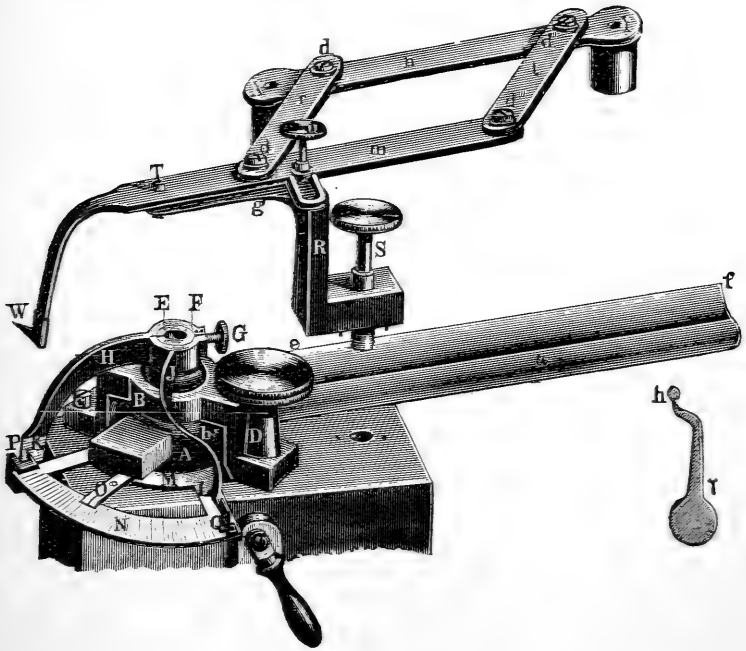
Apparatus for controlling the position of the Microtome Knife.*—Dr. T. v. Dembowski's contrivance consists of two distinct parts. In the first of these the knife *a* (fig. 90) is fixed by the ball-and-socket joint A, the ball of which lies in a hollow excavated in the upper surface of the slide. The arch B covering the ball is fixed by the screws *c* and D. From above B projects a short tube E, which forms part of the ball. Inside the tube E is a binding-screw, accessible through the opening; another, *b*, is seen at the side. Fitting over E, and fixed by the screw G, is another tube F, with two arms H and J. At the end of H is a scale K, and at the end of J a pointer L; the latter is at right angles to K. Encircling the excavation in the slide is a wall-like ring, about which the plate M turns; at the end of this plate is a pointer P. The other end of M carries a vertically placed plate Q, provided with a scale. The end of the pointer P is distant about 90° from Q, so that when the pointer P touches the scale K the point L is brought into contact with the plate Q. The pointer O indicates on the scale N what angle the edge must form with the middle plane of the microtome in order to be able to cut objects of given size when using the whole length of the blade.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 337–45 (2 figs.).

'The second part of the apparatus (which in fig. 90 is raised above its ordinary position for the purpose of rendering its parts more conspicuous), consists of a plate R, fixed to the slide by the screw S and two pegs. From R projects, over the ball-joint, the piece *g*, to which is applied the bar *m*, fixed by a screw *u*. Through *m* and *g* the screw-peg T passes to be inserted in the centre of the ball-joint. The left end of *m* terminates in the pointer W, and this is so situated that it points to the same division of the scale K as P does.

The pieces *r n t m* form a parallelogram, with movable joints at *d d' d'' d'''*. At the ends of *n* are the diopters X and Y, and the plane in which they lie is parallel to the plane which passes through the centre of the ball, the peg T, and the pointer W.

FIG. 90.



To the right of the lower part of the illustration is the piece γ, which is fixed to the object-carrier, and bears at its free end the knob *h*. This piece and the knife are so arranged that the ball *h* touches the under surface of the knife near its edge, throughout its length; and when this has been accurately effected, the division of the scale K, which the pointer P indicates, is noted.

A definite position or line is thereby obtained, so that the knife can be raised or lowered without deviating from its correct position, and, in other words, it may be said that the purpose of the foregoing apparatus is to enable the microtomist to put the section line of the knife in a plane parallel to the course of the slide, and also to render it possible to lower the edge and raise the back without the plane which the knife-edge

describes ceasing to be parallel to the course of the slide. We cannot pretend, however, to have very clearly understood the author's views.

Sectioning fresh Cartilage by partial Imbedding.*—Mr. B. L. Oviatt first removes the end of the bone by cutting through it at 2 or 3 centimetres from the joint. The well of the microtome is then filled with paraffin to within about one centimetre of the top, and as soon as it begins to turn white from cooling the bone is inserted until the cartilage is in the plane of the microtome or a little below it. While the paraffin is cooling the cartilage is prevented from drying by placing on it a little cotton wool wet with artificial serum or salt solution. By this method sections may be obtained of uniform thickness, and more rapidly than by the old method. It is also applicable for sectioning injected tissue if care be taken to cut very slowly and with a drawing motion, and at the same time to keep the tissue and knife wet with 25 per cent. spirit.

Cutting Sections of delicate Vegetable Structures.†—Mr. W. A. Haswell considers there is a difficulty in obtaining by the means ordinarily recommended, with considerable pains and loss of time, a number of fine sections of such delicate vegetable structures as the prothallium of a fern, fronds of delicate seaweeds, or thin and flexible leaves of land plants; and that the following method, which he has found of service, will recommend itself by its simplicity.

The specimens to be cut, if they have been in alcohol, are placed in water for a few hours, and then for a day in a thick solution of gum arabic; if fresh they may be placed at once in the gum. Small pieces of carrot are placed in the gum for the same length of time. The specimens to be cut and the carrot which is to form the imbedding material are now thoroughly saturated with strong gum solution. Slits are made in the pieces of carrot, and the thin structures to be cut are inserted in the slits, any interstices being filled up with gum. The blocks of carrot, with the imbedded specimens, are then frozen and cut in the usual manner with the freezing microtome. When the sections are placed in water there is little difficulty in picking out the sections of the imbedded objects from the light-coloured and flocculent sections of the carrot—an operation which is facilitated by agitation of the water, when most of the narrow needle-like sections of the thin objects will find their way to the bottom of the vessel.

KÜHNE, H.—**Dr. R. Long's neues Mikrotom.** (Dr. R. Long's new microtome.)
Breslauer ärztl. Zeitschr., 1886, pp. 284–5.

[OSBORN, H. L.]—**On treating Chicks for Section-cutting.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 29–31.

Queen & Co.'s (J. W.) New Model Microtome. [*Post.*]
The Microscope, VII. (1887) p. 17 (1 fig.).

REEVES, J. E.—**Cutting Sections of Animal Tissues.**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 12, 14–5,
St. Louis Med. and Surg. Journ., li. (1886) pp. 340–4, lii. pp. 159–60.

SMITH, J. L.—**[Making Sections of Embryo Chicks.]**
Amer. Mon. Micr. Journ., VIII. (1887) pp. 37–8.

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* St. Louis Med. and Surg. Journ., li. (1886) pp. 208–9.
† Proc. Linn. Soc. N. S. Wales, l. (1886) p. 489.

(4) Staining and Injecting.

Staining the Retina by Weigert's Method.*—Dr. R. Lennox hardens the retina of man and of the cat in Müller's fluid and alcohol, and imbeds in celloidin. The sections are placed for about twenty-four hours in a 1/2 to 1 per cent. chromic acid solution, and then, after having been washed in water, in Weigert's hæmatoxylin (1 part hæmatox., 10 parts alcohol, 90 parts water). If kept at a temperature of 40° C. they remained in the logwood solution for two hours; if at ordinary temperature, a longer time. The sections were then decolorized by the cyanide solution (ferrocyanide of potash 2·5, borax 2, water 100). When they became yellowish (about half an hour) they were washed, dehydrated, and mounted in balsam. Nerve-fibres (cat) came out as dark varicose threads. Two kinds of ganglion cells were distinguished:—(1) large yellowish elements with bright nuclei and black nucleoli; (2) dark cells with perfectly black nuclei. In the internal granular and epithelial layers (man) this difference of the nuclei also occurs. The nuclei of the cones are usually black, those of the rods bright with black nucleoli. Of these differences the author offers no explanation.

Staining Tubercle Bacillus.†—Herr Gottstein attacks Ehrlich's explanation of the Ehrlich staining process, i. e. the investment theory which supposes a qualitative difference, while Gottstein and others only accept the presence of a quantitative difference. The author calls attention to the fact that a property of certain constituents of the formula used for staining renders it possible to dissolve twice as much of the dye as distilled water would take up. Consequently the solution acts from concentration and not by any specific virtue. Then as regards resistance to mineral acids, treatment with decolorizing agents shows that the more lightly a dye is bound up to the tissue the more easily is it disassociated therefrom, a confirmation of Gierke's dictum that staining in general is not a chemical but a physical process, and depends on diffusion and imbibition. The resistance of the tubercle bacillus to decolorizing agents is to be explained, according to the author, by supposing that it has a quantitatively slight disposition for imbibition of solutions.

Phenomenon in Anilin Staining.‡—Mr. E. H. Wagstaff in the summer of 1884 mounted several slides of desmids, *Spirogyra*, and other algæ, the mounting substance being the article commonly known as "French polish," coloured with the addition of a little anilin-green and well mixed together. The slides were spun in the usual manner on the turntable, the cells being finally finished off with a last touching-up with the "French polish." About six months after he found the specimens had become stained a beautiful and vivid green, of course rather too vivid, but nevertheless quite a surprise. The specimens stained were *Spirogyra inflata*, *S. Weberii*, *S. quinina*, *Staurospermum gracile*, and *S. viride*. The desmids so treated were *Closterium rostratum* in conjugation, and *C. Leiblorii*, &c.

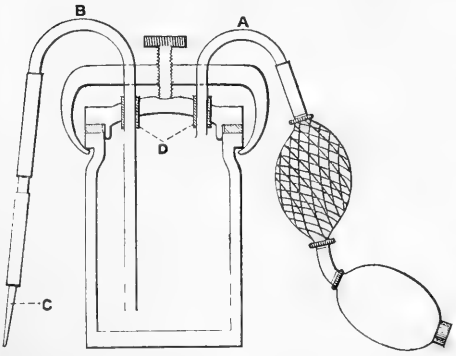
Congo Red.§—Dr. F. Nissl gives the following (provisionally) as a staining method for axis cylinders:—Chromate of potash; alcohol, 95 per cent.; watery solution of Congo red, 5 to 400; alcohol, 95 per cent., three

* Arch. f. Ophthalm., xxxii. (1886) 8 pp. and 1 pl.
† Deutsche Med. Wochenschr., 1886, No. 42.
‡ Sci.-Gossip, 1887, p. 41. § Münchener Med. Wochenschr., 1886, p. 528.

to ten minutes; nitric-acid-alcohol ($3HNO^3$ to 100 C^2H^6O), about six hours; alcohol, one to five minutes; oil of cloves or origanum; balsam.

Gage's Injecting Jar.*—Prof. S. H. Gage's injecting jar (fig. 91) grew out of the necessity for some simple and efficient apparatus for injecting liquids (chloride of gold, nitrate of silver, nitric, chromic, osmic, and picric acids) which would be injured by or injure an ordinary syringe. As will be seen, it is made on the principle of an ordinary wash-bottle. It is prepared by boring two holes in the glass cover of a fruit-jar or of an anatomical specimen jar, and inserting glass tubes, the pressure-tube A just penetrating the cover and the delivery-tube B extending nearly to the bottom of the jar. Where the glass tubes penetrate the cover they are surrounded by rubber tubing D, to render the joints air-tight. The pressure is obtained by the use of an atomizer bulb, or, in order that it may be constant, two bulbs are used, the second one being covered with a net to prevent undue distention. The delivery-tube and the cannula C are of glass, only enough rubber tubing being used to make the delivery-tube outside the jar flexible.

Fig. 91.



While this jar was designed for special liquids, it has been found excellent for making fine injections with gelatin mass. With two bulbs, as in the figure, a pressure of 40 mm. of mercury may be obtained; this is sufficient for most purposes. While water or mercury might be used to obtain the pressure, as in the various forms of constant pressure apparatus, the atomizer bulbs are preferred, as it is easier for the operator to control the pressure and adapt it to the individual cases.

Stein's Injection Apparatus.†—The injection apparatus used by Dr. S. T. Stein is shown in fig. 92. In this instrument the required force is derived from the action of compressed air upon a column of liquid, and it consists accordingly of two parts—A the compression-pump, and B the vessel which holds the liquid. The pump A, made of guttapercha, consists of an air-bag *m* into which air is forced by means of a collapsible ball and the two valves *a* and *b*. From *m* the air passes by the tube *c f* into B through the rubber-stopper *d*, which admits by air-tight openings that and another tube *g h*. The end *f* of the first tube does not penetrate far into the vessel, but the second tube *h g* extends into the injection-fluid, while its other end *i* is closed by the stop-cock *k*. When the stop-cock is open the apparatus yields a continuous stream from 2½–3 metres in height, which by closing *k* may be reduced to a slow succession of drops. B stands upon the support *e*, and is immersed in a water-bath *w*, which is heated by the spirit-lamp *t* in the chamber *s*.

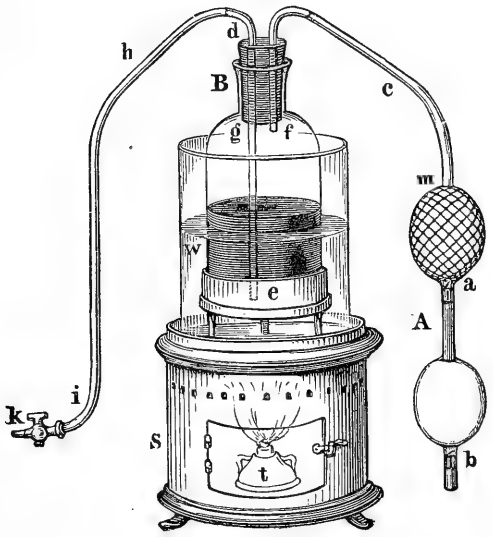
For this apparatus the author claims the advantages that it is completely under the control of the operator, whose hands are moreover left free; it may be used for all sorts of cold and warm injections, including chemical

* The Microscope, vi. (1886) pp. 265–6 (1 fig.).

† Stein, S. T., 'Das Licht,' 8vo, Halle, 1884, pp. 307–10 (1 fig.).

solutions such as nitrate of silver, and none of the liquid is lost, while the whole apparatus is easily cleaned by pumping a stream of warm water through it.

FIG. 92.



Nitrite of Amyl for Fine Injections.*—Messrs. B. L. Oviatt and E. H. Sargent suggest the employment of amyl nitrite for fine injections, and point out three methods for its exhibition. 1. A mixture of ether and amyl nitrite may be poured into the box in which the animal is killed, and when quite anæsthetized a sponge moistened with pure nitrite may be held over the animal's nose until it is quite dead. This procedure is not recommended. 2. After being anæsthetized with ether, the nitrite may be held over the nose, or the animal may be removed from the box, and after the sponge is applied the head wrapped up in a rubber sheet. 3. Injection of a small amount of nitrite in salt solution into the vessels directly after death by either of the foregoing methods. In any case it is advisable to add a little nitrite to the mass just before using. The relaxing power is so great, that the largest arteries will be found collapsed.

DEKHUYZEN, M. C.—**De aard van het proces der Kleuring van mikroskopische praeparaten.** (The nature of the process of staining microscopical preparations.) *Nederl. Tijdschr. v. Geneesk.*, 1886, pp. 585–8.

GRAY, N. M.—**A Modification of Weigert's Method of staining Tissues of the Central Nervous System.** [*Post.*] *Amer. Mon. Micr. Journ.*, VIII. (1887) pp. 31–2, from *Med. News*, 1886, Nov. 6.

GRIGORJEW, A.—**[On Ehrlich's Staining of Micro-organisms.]** [In Russian.] *Russkaja Medecina*, 1886, No. 42.

HANKIN, E. H.—**Some new Methods of using the Aniline Dyes for staining Bacteria.** [*Post.*] *Quart. Journ. Micr. Sci.*, XXVII. (1887) pp. 401–11.

KÜHNE, H.—**Zur Färbetechnik.** (On staining technique.) *Zeitschr. f. Hygeine*, I. (1887) pp. 553–6.

S., R. J.—**Staining Fluid.**
[Carmine, 10 grns.; strong liquid ammonia, 1/2 drachm; Price's glycerin, 2 oz.; distilled water, 2 oz.; alcohol, 1/2 oz.].
Scientif. Enquirer, II. (1887) p. 30.

* St. Louis Med. and Surg. Journ., li. (1886) pp. 207–8.

(5) Mounting, including Slides, Preservative Fluids, &c.

Thymol in Microscopical Technique.*—Dr. G. Martinotti concludes from his own experiments and the researches of others that although thymol may have a useful application in microscopy as an antiseptic, it should not be employed when the tissues to be examined have been or are to come in contact with chromic acid or its salts.

If to a watery solution of chromic acid a watery solution of thymic acid be added, a precipitate forms, even when not exposed to light, and this precipitate is devoid of the characteristic smell of thymol. After washing the precipitate, the filtrate is found to be a yellow odourless powder, which examined microscopically consists of amorphous granules and a few small prismatic crystals. This precipitate is insoluble in water, insoluble or nearly so in alcohol, ether, chloroform, benzine, in water acidulated with sulphuric, hydrochloric, nitric, acetic, formic, and oxalic acids, in ammonia, in anilin diluted with alcohol. If an alcoholic solution of thymol be added to the watery solution of chromic acid the action is so energetic that the temperature rises from 70° to 80° C. The precipitate is produced as before, but the mass assumes a blackish colour, as if mixed with some carbonaceous matter.

Again, if thymol crystals be thrown into the chromic acid solution they become invested by a precipitate, while their central parts retain their usual character. With solution of potassium bichromate similar results follow, but more slowly.

Hence a chemical action takes place between thymol and chromic acid, and this action is a process of oxidation. So the writer assumes from the researches of Lallemand, Carstanien, and others who have examined the relations and composition of thymol.

As remarked above, the conclusion arrived at is that thymol is unsuitable as a microscopical reagent in conjunction with chromic acid or its salts. With other reagents, such as picric acid, carmine, gum, and gelatin, thymol works well.

Hilgendorf's Apparatus for Dehydrating Microscopical Preparations.†—Herr F. Hilgendorf's apparatus consists of a test-tube (for small objects, about 50 mm. long and 6 mm. broad) into which is filed, about 5–10 mm. above the bottom, a small hole. The aperture may, if necessary, be lessened by means of a wood-splinter. The object is then placed in this tube, *partially* filled with weak spirit, and the upper end closed with a cork. Thus prepared, the tube is inserted into a closed vessel filled with absolute alcohol. Through the small hole the latter finds its way into the tube, and continues to do so for a half to one hour. At a height of 1 cm. diosmosis was found to require several days, but the rapidity of the action can be proportionately increased by filing the hole lower down. Several tubes, and this is a great advantage, can be placed in the outer vessel at the same time. It is recommended to use some hygroscopic substance, as burnt copper sulphate, &c., to keep the dehydrating fluid as concentrated as possible.

Method for treating Serial Sections imbedded in paraffin by Weigert's method.‡—Weigert's method of making serial sections of celloidin preparations was described in this Journal, 1886, p. 349.

Prof. H. Strasser describes the following improved method, in which

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 351–8.
† SB. Gesell. Naturf. Freunde zu Berlin, 1886, pp. 133-5.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 346–50.

the stiff glass plates are replaced by a pliant medium that allows fluids to penetrate from both sides, the paraffin-imbedded sections being attached to gummed paper by means of collodion.

The gum-collodion plates are made by covering one side of a smooth piece of writing-paper, duodecimo size, with a thick layer of gum arabic. As soon as the gum ceases to be sticky, the paper is flattened out smooth in a hand-press, care being taken that there are no uneveunesses. Thick-flowing collodion is now passed over the gummy side, and a smooth layer having been obtained, the plate is again pressed out between two firm, smooth surfaces in the hand-press. Upon the plate thus obtained the sections are then fixed by means of a mixture of 2 parts collodion and 1 part oil of cloves. For large and thin sections it is necessary to use a section-stretcher of special construction. This, however, remains to be described. Over the whole a thin layer of the collodion clove-oil mixture is then brushed with a camel's-hair pencil.

The paraffin is next dissolved out by laying the plate in a dishful of benzin for 15–30 minutes. The plate is then dried with blotting-paper, and at once transferred for a few minutes to 95 per cent. alcohol. It is then dried again, and to keep up a perfectly smooth surface the sections must be brushed over, if need be, with the collodion clove-oil mixture. It is next transferred to 80 per cent. alcohol, wherein it remains for a quarter of an hour or more. When sufficiently hard, these plates may be treated in any watery or water-and-spirit solution. The watery solutions of course set free the collodion plate by dissolving the gum. Clearing up and mounting are performed in the usual way with creosote and Canada balsam.

Permanent Caustic Potash Preparations.*—It is usually stated that specimens treated with caustic potash cannot be permanently preserved. During the past summer an aqueous solution of caustic potash of 35 to 40 per cent. was used by Prof. S. H. Gage for isolating cardiac muscle from many different animals; as some of the preparations were drawn it seemed unfortunate not to be able to render them permanent as vouchers for the drawings. This was accomplished by adding glacial acetic acid to the isolated cells. The acid combines with the caustic potash to form acetate of potash, which is often used for permanent mounting; finally a mixture of glycerin 75 parts and an aqueous solution of picrocarmine (1 per cent.) 25 parts was added as a permanent mounting medium. These specimens after three months show no signs of deterioration. If the specimens were already under the cover-glass, a drop of glacial acetic acid was drawn under it and afterwards a drop of the glycerin and picrocarmine mixture.

How Alcohol drives out Air-bubbles.†—M. L. Errera remarks that that which renders air-bubbles so persistent in organic tissues is, in the first place, their extreme minuteness; then the thin layer of water which encompasses them holds in solution a certain quantity of organic matter; whence arise an increase of the superficial viscosity, and a diminution of the tension, both favourable to persistence.

But the air-bubbles should disappear if for water be substituted a liquid endowed with the three following properties:—(1) It must be perfectly miscible with water. (2) Its superficial tension must be weak. (3) Its superficial viscosity must be weak. Now, of all the liquids indicated by Plateau, who has made some very original observations on the superficial and internal viscosity and tension of fluids, only two fulfil both conditions. These are ether and alcohol, both of which ought to rapidly drive out air-

* The Microscope, vi. (1886) p. 267.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 69–75.

bubbles from microscopical preparations. As the superficial viscosity of ether is very feeble, and its tension less than that of alcohol, it should be preferable for the purpose to the latter, though it must be borne in mind that ether is not miscible with water, like alcohol, in all proportions. But, as a matter of fact, experience shows that ether does cause to disappear, just as alcohol does, the air-bubbles adhering to organic tissues.

Krönig's Cement.*—Dr. Krönig calls attention to the convenience of a sealing cement composed of two parts of wax and seven to nine parts of colophonium. The colophonium is added piecemeal to the melted wax, the result is filtered, and the mass left to cool. Solid at ordinary temperatures, it is readily melted by placing the containing vessel in hot water. As it hardens rapidly, the preparation can be finished at once. It is insoluble in water, glycerin, and caustic potash; its consistence is good; its composition is cheap and simple.

Aylward's (H. P.) Opaque Wood Slide.

["Parallel-sided, sunk cell, beyond which is a parallel-sided groove to hold a brass-flanged ring. The object is put into the cell, a thin cover-glass laid on the top of it, and the brass ring dropped into position holds all perfectly secure, and if pressed tightly down, we believe, air-tight also. The special qualifications Mr. Aylward claims for this slide are its simplicity, and also that owing to the dryness of the wood botanical objects need not be thoroughly dried before mounting. The wood will absorb all dampness that may be left, and in so gradual a manner that all shrinking or curling of the specimen will be avoided."]

Scientif. Enquirer, II. (1887) p. 39.

GAGE, S. H.—**Centering Card.**

[The card is prepared by making upon it several concentric circles, and then cementing to it pieces of glass or Bristol board, so that when the slide is placed in position the centre will be over the centre of the circles.]

The Microscope, VI. (1886) pp. 266–7 (1 fig.).

GUARDIA, J.—**Hints for Microscopists.**

[To view preparations from both sides with high powers:—Two thin strips of wood, brass, cardboard, &c., 3 in. × 1½ in. From the centre of one cut out a square 3/4 in. side, and from the other a square slightly larger than 7/8 in. side. Glue the two strips together, and there is a ledge 1/16 in. for the preparations to rest on. The specimens are mounted between two 7/8 in. cover-glasses and put in the frame or carrier.]

Engl. Mech., XLV. (1887) p. 11.

HEURCK, H. VAN.—**Nouvelle préparation du Médium à haut indice (2·4) et note sur le liquidambar.** (New preparation of the medium of high index (2·4), and note on liquidambar. [*Post.*] *Bull. Soc. Belg. Micr.*, XIII. (1886) pp. 20–4.

MORRIS, W.—**Notes on experiments in mounting the Amphipleura pellucida in media having a higher refractive index than Canada balsam.** [*Post.*]

Journ. and Proc. R. Soc. N. S. Wales, XIX. (1886) pp. 121–33.

VRIES, H. DE.—**Over het bewaren van plantendeelen in spiritus.** (On the preservation of parts of plants in spirit.) [*Post.*] *Maanbl. v. Natuurwet.*, 1886, No. 5.

(6) Miscellaneous.

Two new Sugar Reactions.†—Dr. H. Molisch found that sugar solutions, with the exception of inosite, immediately assume a deep violet colour on the addition of some drops of a 15–20 per cent. α naphthol solution and sulphuric acid in excess, and that the addition of water then produced a deep violet precipitate. If thymol be added to the α naphthol the colour becomes a bright ruby red, and the precipitate, from water, is carmine red. In this way 0·00001 per cent. of sugar can be demonstrated. Carbohydrates and glucosides also give these reactions, but more slowly, and after the action of sulphuric acid.

* Arch. f. Mikr. Anat., xxvii. (1886) pp. 657–8.

† SB. K. Akad. Wiss. Wien, xcii. (1886) pp. 912–23.

From the foregoing considerations Molisch bases the following method for demonstrating sugar in plant sections:—A not too thin section laid on a slide is treated with a drop of 15–20 per cent. alcoholic α naphthol solution, then two or three drops of concentrated H_2SO_4 are added. If the section contains sugar the violet coloration appears in less than two minutes. In other carbohydrates the colour appears in a quarter to half an hour. In practice two sections are used; one of these is boiled for a few minutes in water, whereby sugar, dextrin, gum, and glucosides are dissolved. The two sections are then submitted to the same test, and if sugar is present in the unboiled section the coloration immediately appears. As dextrin, gum, and glucosides may be usually disregarded, the appearance of the violet, &c., staining indicates with great probability the presence of sugar.

The foregoing test may be used to demonstrate the presence of inulin, which by Sachs's method is liable to be confounded with sphæro-crystals, for these become immediately stained deep violet with α naphthol and sulphuric acid, and on the addition of thymol are dissolved with the production of a red colour.

These reactions may be used for the detection of sugar in urine. Without any preparation normal human urine exhibits them distinctly, even when it is diluted from 100 to 300 times; and the presence of grape-sugar is therefore absolutely determined in the urine of man in a normal condition. A simple method, based on these reactions, is given for the distinction of diabetic from normal urine.

Discrimination of Butter and Fats.—Prof. H. A. Weber * has made further experiments upon the microscopic methods of distinguishing butter from other fats proposed by Dr. T. Taylor. †

Dr. Taylor's first claim was that butter, cooled slowly under certain conditions, formed "globules," which, when viewed by polarized light, showed a well-defined St. Andrew's cross. Prof. Weber having shown that this appearance was not characteristic of genuine butter, but might be produced in any common fat by treatment similar to that applied to the butter, Dr. Taylor then called attention to another test as being characteristic. According to this, if a sample of butter is viewed by polarized light, a plain selenite being placed between polarizer and analyser, a uniform colour is observed; if any solid fat, like lard or tallow, be thus viewed, the fat will exhibit prismatic colours. Prof. Weber finds this test as fallacious as the former. Any of the fats under consideration, if melted, and cooled slowly, and then submitted to Dr. Taylor's test, will show the prismatic colours, due to the action of the comparatively large crystals formed upon the polarized light. On the other hand, the same fats, if cooled quickly, so as to prevent the formation of large crystals, present the uniform tint claimed by Dr. Taylor as characteristic of butter fat.

Dr. Taylor in reply contends ‡ that Prof. Weber's experiments were erroneously carried out, and his views are defended against those of Prof. Weber by Mr. R. Hitchcock. § Mr. C. M. Vorce also corroborates ‖ Dr. Taylor, and describes a modified method of his own.

Dr. J. H. Long, ¶ on the other hand, considers that we have no abso-

* Science, vii. (1886) p. 524, from Bulletin No. 15 Ohio Agricultural Experiment-Station.

† See this Journal, 1885, pp. 356 and 918. It would seem from the above that these two extracts, though given in the order of date of the sources from which they were taken, were chronologically reversed. See also this Journal, 1886, p. 174.

‡ The Microscope, vi. (1885) pp. 78–9, and see pp. 85–6. Amer. Mon. Micr. Journ., vii. (1886) pp. 169–70.

§ Amer. Mon. Micr. Journ., vii. (1886) pp. 119, 135–7. ‖ Ibid., pp. 156–7.

¶ Bull. Illinois State Micr. Soc., May 14, 1886, 5 pp. and 1 pl.

lutely certain method of distinguishing between butter and some of its substitutes, and that of all methods proposed, the microscopic are perhaps the least reliable.

Microscopic Structure of an Armour-plate.* — Dr. H. Wedding describes the microscopical examination of a compound armour-plate, from which it appears that the different varieties of iron and steel used in the construction of such a plate can be recognized without difficulty by means of the Microscope. The plate examined, which was one of the largest used (300 mm. thick) consisted of a base composed of a series of hammered plates of puddled iron 35 mm. in thickness, welded together into a plate of 215 mm. thickness; a face of cast iron (containing 0·45 per cent. of carbon) rolled into a plate 15 mm. thick; and an intermediate layer of steel which had been run in between these two plates and allowed to solidify; the whole being finally rolled at a red heat.

A transverse section was polished, cleaned with water, alcohol, and ether, etched with a weak solution of hydrochloric acid (one drop of acid in a litre of water), cleaned a second time, and then tempered to a yellow tint, when the etched figures stood out in orange upon a yellow ground.

The section was then submitted to microscopical examination and the following features were observed. The surface-plate displays the characteristics of cast iron poor in carbon, namely homogeneous iron with uniform inclusions of angular flakes and crystals of iron; in the steel plate the homogeneous iron is reduced to a network enclosing large masses of crystallized iron and small pores; while the base-plate is characterized by welding joints in the form of pores permeating stringy iron in which the crystalline structure is developed parallel with the joints. The quantity of crystals present may be regarded as an indication of the percentage of carbon, and they are seen to diminish in number where the otherwise homogeneous iron of the surface-plate comes into contact with the steel. Other changes of character observed near the point of contact of the different materials are detailed by the author and suggest that the Microscope may perhaps be used not only to determine the nature of the metal, but also to estimate its homogeneity, purity, &c.

Microscopist's Working Table.†—In a series of articles on "The Naturalist's Laboratory" by an anonymous writer, a microscopist's working table is thus described:—"As a very large part of the naturalist's work nowadays calls into use that most useful of modern inventions, the compound Microscope, a special table designed to facilitate research must here be looked upon as something indispensable. The objects of the design, now submitted to the notice of students of nature for the first time, are to afford general convenience during study, and to enable one to record observations graphically on the spot. To accomplish these the table is divided into two parts, the microscopist's, M (figs. 93 and 94), and the artist's portion, D. The dimensions of the table are clearly indicated on the figures. Fig. 93 is a working plan to show the end elevation of the structure; fig. 94 gives a good idea of the shape of the table-top. Each part is furnished with two drawers as shown in fig. 93; the drawers under D afford space for the storage of colour-boxes, pencils, paper, &c.; those beneath M are intended to receive microscopical accessories, such as glass slips, instruments, live-boxes, troughs, and the hundred and one odds and ends that may be required from time to time by the worker in Nature's unseen universe.

* Verh. Ver. zur Bef. d. Gewerbfleisses, 1886, p. 293. Cf. Naturforscher, xx. (1887) pp. 18–9.

† Knowledge, x. (1887) pp. 80–1 (2 figs.).

"The longest end of the table ought to face a window approximately looking northwards. The worker seated on the bench T can thus employ direct or reflected light according to the position, inclined, upright or horizontal, in which he places his Microscope. To his right there is fixed a reagent stand, R. As soon as he has completed his observation, or adjusted an object which he deems worthy of delineation, he should shift his instrument to the position D and take his seat upon the chair S. By so doing, he will gain the inestimable advantage of working in a clear

FIG. 93

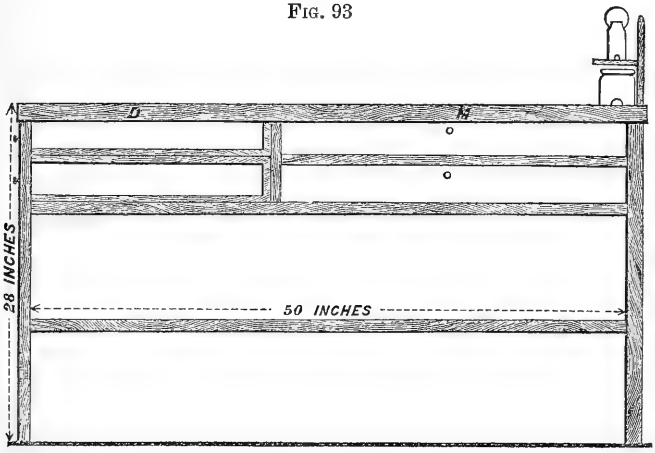
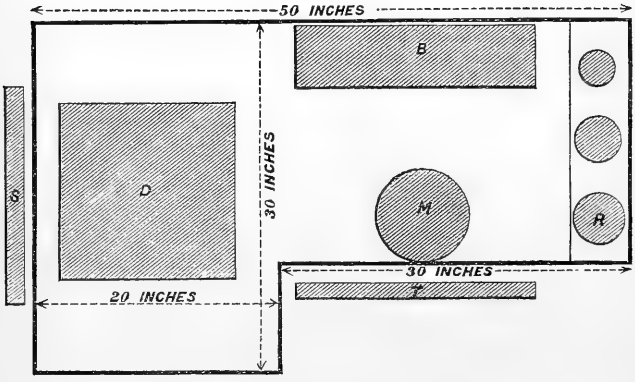


FIG. 94.



transmitted light without the chance of a vitiated result through interference rays, and with absolute security against the evil effects of a more or less intense glare. The value of thus being able to shift one's position from front to side on the table will soon become evident to workers with the Microscope who indulge in prolonged observations. The top plan (fig. 94) shows the position of the Microscope during investigation, or whilst mounting objects; B, place for a dust-proof box, for use whilst preparing specimens for observation, a detailed description of which will be given in the sequel;

D, the position of the Microscope when used with the camera lucida for delineating objects, or when employed with the polariscope, or where pure transmitted light is alone admissible; R, the reagent-stand."

Ward's Catalogue of Microscopical Collections.—Dr. R. H. Ward has prepared a convenient form of catalogue for recording a large number of brief data of objects. Each double page has space for 10 objects and the data are grouped in four columns. Below is a specimen of the heading of a page and one of the 10 spaces; the columns for preparation and mounting are not, however, beneath the other two but run across the right-hand page. Each book contains space for 1000 or 2000 objects as preferred. There is an appendix for long notes, special methods, formulæ, &c., and an alphabetical index.

(*Left-hand Page.*)

Slide No.	NAME. c. Common Name. s. Scientific Name. N. Special points shown, Illumination or Powers required, Reference to authorities, &c.	SOURCE. h. Habitat or Locality. c. Collector (Presented, Purchased, Exchanged, &c.)
	c	h
1	s	c
	N	

(*Right-hand Page.*)

PREPARATION.	MOUNTING.		
p. Preserved (Hardened, Macerated, Decalcified, Injected, &c.). ct. Cut (Imbedded, Frozen, Microtome), Teased, &c. st. Stained. cl. Cleared.	m. Mounting Medium. cc. Cell and Cement. cg. Cover-glass Thickness. | d. Date. | lc. Location in Cabinet. r. Repairs or Disposal (Broken: Cement run in: Air in: Given to or Exchanged with, &c.).		
p	m		
ct	cc		
st	cg	d . .	lc
cl	r		

Dr. Dallinger's Address.—The following * is a popular appreciation of Dr. Dallinger's last address.

"It is difficult to say whether the wonders that reward the patient servants of science are more attractive in the direction of the infinitely little or of the infinitely great. In both of these fields there are faithful workers, constantly striving to enlarge for us the bounds of human knowledge, albeit

* Daily Telegraph, 19th Feb., 1887, p. 5.

mankind is not grateful enough for their toil. Experimental researches, like those which Mr. Crookes explained last night at the Royal Institution, force the mind to consider matter in its ultimate and minutest forms as analysed by the electric spark and the spectroscope, in atmospheres millionths of our common air in tenuity; and they are not less wonderful than the contemplation of worlds thousands upon thousands of times larger than our own. Our astronomers are engaged at present in photographing the face of the midnight heavens, having discovered that the film which they expose to the sky is far more sensitive to light than the keenest human eye, and more than one observatory is thus registering distant and minute stars previously unknown. The stellar universe has been by such means perceived to be more crowded with life and glory than had been realized; and night after night the astronomer's camera in this silent way prints off accurate pictures of seen and unseen immeasurably distant worlds. Meanwhile, coming from the realms of matter to the sphere of life, the microscopists are quite as busy as the telescopists, and the results which they achieve, although drawn from regions that escape us by minuteness, often shed new rays of truth over those problems of living nature which baffle us by their vastness. The Rev. Dr. Dallinger, President of the Royal Microscopical Society, delivered an address last week which well illustrates this view, while it gives an example of the admirable and unceasing devotion shown by our best scientific men. After dwelling on certain recent improvements in the construction of lenses, the President, on the occasion referred to, proceeded to describe a series of experiments which he has conducted for nearly ten patient and faithful years. Long ago Darwin expressed the opinion that if we would actually observe and demonstrate the manner in which living creatures adapt themselves, by inward and outward modifications, to changed circumstances, and so produce what are called new species, it must be by watching the lowest and least visible organisms. To such a task Dr. Dallinger set himself. His project was to place and keep under his lens several varieties of those minute monads which are incessantly multiplying by fissure or division, and which are nearly at the bottom of animated nature. The generations of these creatures succeed each other about every four minutes; so that, in the course of an hour, we can view the passage of fourteen or fifteen generations, which would answer to something like four hundred and fifty years of human history, while a day of monadic existence would represent more than ten thousand of our years. These monads live in water, and by connecting the drop that serves them for a habitable and roomy ocean with the ingenious apparatus of Prof. Schäfer the temperature of this drop can be either kept constant or raised very slowly and with absolutely steady precision. Here, therefore, were the conditions requisite for gradually altering the climate in which these monads throve; and if it could be proved that such tiny infusoria could indeed be slowly accustomed to changes greater than would be suffered by animals removed from the Equator to the Pole, then bright and trustworthy light would be cast on the modifications of life which we see arrived at on the earth, and Darwin's great law would be largely removed from theory to recorded fact. To carry out so very delicate an investigation, however, it would have to be prolonged for months and even years, in order to imitate the immense deliberation with which Nature herself accomplishes every substantial change in her highest productions. Night and day, winter and summer, the patient gaze must be kept fixed on those merest specks of silvery life which had to be nursed into new conditions of existence. The slightest accident to the apparatus might in one moment render the whole experiment void, and leave the drop of water as lifeless as these islands

would be if another glacial period suddenly arrived. The only reward, on the other hand, for successful and almost inconceivable perseverance would be the discovery of truth, and the reinforcement of Darwin's sublime generalisation. But, for the sake of these, which always satisfy the noble ardour of science, Dr. Dallinger has given as many years of his life as were spent by the Greeks in the siege of Troy, and has apparently won a scientific victory, the value of which is as signal as his ingenuity and devotion are admirable.

We will endeavour very briefly to describe the method and the outcome of his most remarkable experiments. The group of microscopic monads were put under the lens in a well-fitted water-cell at their usual temperature of 60° F., the apartment, the apparatus, and all round being carefully kept in precise unison. The Doctor then spent the first four months of his observation in raising the temperature time after time by stages less than one-sixth of a degree, until his swarm of protozoa had reached the new and advanced reading of 70° F. This change, nevertheless, had no more disturbed them than that experienced by a British family when it migrates from London to Cape Town; the life-history of each group remained unaltered; they moved, gyrated, fed, and split themselves into new individuals in just the same manner and within much the same period as before. When, however, three more degrees had been added to the seventy, the monads showed signs of being decidedly inconvenienced. They were neither as lively nor as productive as formerly; yet, by keeping them exactly at this range during two quiet months they regained their full vigour, and might be compared to emigrants who had become seasoned by surviving the first hot spell in a tropical country. They could now stand—by gradual steps of increase—the enhanced heat of 78°, which was reached at the commencement of the twelfth month. Yet here, again, a long pause was found to be necessary; the new generations of those silver specks of life under the glass were not all alike strong enough to live and thrive. What answers to sunstrokes and fevers with us had caused vacant spaces to appear in the water-drop, and it was only when the monads showed themselves once more lively and prolific by a long era of repose that the careful Doctor administered a further dose of caloric. During eight years and a half did he thus slowly and unweariedly proceed in the same course, augmenting the heat of their surrounding element now and then by slow and slight additions, pausing afterwards for months to give the minute creatures time to accommodate themselves when signs were visible that they were under difficulties, and always going forward to new trials of endurance when they had recovered. In this manner, after all those many years, Dr. Dallinger brought his small patients to the astonishing range of 158° F., at which the latest generation appeared 'as jolly as sand-boys.' It is not possible to say how much farther their tiny constitution could have been trained to defy increasing warmth, because the research was at this point accidentally terminated; but it will be seen that the Doctor had brought the little people of his drop-world to sustain a heat nearly one hundred degrees higher than the flourishing point of their ancestors, any species of which, if taken at the beginning, would have been completely and instantaneously killed in water of one hundred and forty degrees. When we have added that these minute salamanders perished directly they were put back into their ancestral medium of sixty-five degrees, if will be manifest that the indefatigable Doctor had, by the magic of science, effected a miracle of Nature almost as striking as if the *Protococcus nivalis*, which stains the Arctic snow with crimson, had been transformed into the great grasses and feathery bamboos which clothe the burning sides of a mountain under the Equator.

The biological importance of these observations will furthermore be evident to all intelligent minds. There must have passed under the eyes of Dr. Dallinger, during his watch, something like half a million generations of the minute organisms. His augmentation of temperature had meanwhile represented the sudden changes which may have come upon earth-life, while his pauses answered to those periods of steadfast conditions which must have intervened, and given to living things leisure to accommodate their organs to new circumstances. Thus the ages of our planet's history were condensed, so to speak, under the vigilant eye-piece of the Doctor's Microscope, and these seven or eight years of observation furnished an epitome of the earth's entire existence. They proved to demonstration in these low forms what we can only guess at with regard to the higher plants and animals. Darwin constantly insisted upon the slowness of the process of adaptation, and, if we should seek to transpose the advances and the pauses of these seven or eight years into terms proportionate for higher orders of life, the figures would become truly prodigious. Yet no change from sea to land, or from icebergs to tropical forests, could be relatively greater than that triumphantly borne by these infusoria. And, if it be objected that they are of an organism too degraded and too primitive to bear any practical relation to the highest grades of life, the answer is obvious and convincing. Those higher species, whether plants or animals, are mainly built up of vast aggregations of cells; and these cells, though differently endowed in different parts of the frame, are very like the monads in many respects. Thus the patient experiment has, in truth, a clear and most valuable bearing upon the problem of gradual evolution in all its stages and illustrations, and light is cast upon the grandest operations of Nature by the way in which these tiny mere dots of protoplasm 'live and move and have their being.' Nor could better proof be wanted of the way in which the infinitely little illuminates, as we have said, and explains the infinitely great."

BOUDIER, E.—**Considérations générales et pratiques sur l'étude microscopique des Champignons.** (General and practical considerations on the microscopic study of fungi.) *Rev. Mycol.*, VIII. (1886) pp. 215–8.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. No. 7 (each 4 pp.).

Sec. I. Botanical Histology. No. 7. Studies in Vegetable Physiology. VII. Haustoria. (Plate VII. Dodder in parasitic connection with clover.)

Sec. II. Animal Histology. No. 7. The Ovary and Ova in Birds. (Plate VII. Ovary of Bird × 50.)

Sec. III. Pathological Histology. No. 7. Fatty Degeneration of Kidney (Phosphorus poisoning). Waxy disease. (Plate VII. Fibrosis of Kidney.)

Sec. IV. Popular Microscopical Studies. No. 7. Microbes. (Plate VII. Microbes.)

JENNINGS, C. G.—**The Microscopic Examination of Urinary Deposits.** *The Microscope*, VII. (1887) pp. 9–10.

KASTSCHENKO, N.—**Methode zur genauen Reconstruction kleinerer makroskopischer Gegenstände.** (Method for the exact reconstruction of small macroscopic objects.) [*Post.*] *Arch. f. Anat. u. Physiol. (Anat. Abtheil.)* 1886, pp. 388–93 (1 pl.).

LONG, R.—**Die Trichine. Eine Anleitung zur Fleischschau.** (The Trichina. A guide to the inspection of meat.) iv. and 31 pp., 20 figs., 8vo, Berlin, 1886.

PELLETAN, J.—**Revue.** (Review.)

[Remarks on the progress of microscopical technique and "diatomologie" in 1886.] *Journ. de Microgr.*, XI. (1887) pp. 2–4.

PENNETIER, G.—**Technique microscopique. Recherche de la farine de blé dans le chocolat.** (Microscopical Technique. Search for flour in chocolate.) *Journ. de Microgr.*, XI. (1887) pp. 35–7.

RAFTER, G. W.—**On the use of the Microscope** in determining the sanitary value of potable water, with special reference to the biology of the water of Hemlock Lake.] *Proc. Rochester (N.Y.) Acad. Sci.*, 1886, 25 pp., 3 pls.

RÜFFERT, F. W.—**Microscopische Fleischbeschau.** (Microscopical inspection of meat.) 2nd ed., xii. and 87 pp., 40 figs., 8vo, Leipzig, 1887.

Seeds for Microscopic Objects.

[Lists of the most suitable by Reymond, Working-Man Botanist, and S. Bottone.]

Engl. Mech., XLIV. (1887) pp. 505–6, 527.

SLACK, H. J.—**Pleasant Hours with the Microscope.**

[Formation of crystals.] *Knowledge*, X. (1887) pp. 107–8 (3 figs.).

VANDERPOEL, F.—**A new Settling Tube for Urinary Deposits.** [*Post.*]

Amer. Mon. Micr. Journ., VIII. (1887) pp. 28–9.

WHELPLEY, H. M.—**The Microscope in Pharmacy.**

["It is undeniable that the Microscope will be one of the important instruments of the drug store of the future. As already referred to, drugs now come into the market in such altered conditions that the naked eye cannot recognize them. This gives great opportunities for adulteration, and microscopy is the most convenient path out of the difficulty. The instrument will grow more and more popular each year, as the profession becomes better educated and the public learns the importance of guarding against inferior or adulterated drugs. Even at the present time the importance to the pharmacist of the study of microscopy is quite generally recognized. The leading colleges of pharmacy have laboratories equipped with facilities for giving the students instruction in this highly interesting and valuable study."]

The Microscope, VI. (1886) p. 280, from *National Druggist*.

WILLIAMS, G. H.—**Modern Petrography**, an account of the application of the Microscope to the study of Geology. 8vo, Boston, 1886.

PROCEEDINGS OF THE SOCIETY.

ANNUAL MEETING OF 9TH FEB., 1887, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 12th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Crookshank, E. M., Manuel Pratique de Bactériologie basée sur les méthodes de Koch. Traduit par M. Bergeaud. ix. and 292 pp., 32 pls. and 44 figs. (8vo, Paris, 1886)	*The Author.*
Ward, R. H., A.M., M.D., Catalogue of the Microscopical Collection of [ ] with an Appendix for notes, special methods, formulæ, &c., and an Alphabetical Index. (4to, Troy, N.Y., 1886)	„

Mr. Crisp said that the meeting would now be made special, pursuant to notice, in order to move the suspension of the bye-laws for the purpose of re-electing Dr. Dallinger as President for another year.

Mr. Carruthers, P.L.S., said he had great pleasure in proposing that the bye-laws be suspended for the purpose of enabling the Fellows to elect the Rev. Dr. Dallinger for a fourth time President of the Society, and he felt sure that the services he had already rendered, as well as the distinguished position which he occupied in the science of microscopy, rendered it quite unnecessary to say anything further to recommend the motion to them.

Dr. Millar having seconded the motion, it was put to the meeting by Mr. Carruthers, and carried unanimously.

The List of Fellows proposed as Council and Officers for the ensuing year was read as follows:—

President—Rev. W. H. Dallinger, LL.D., F.R.S.

Vice-Presidents—*Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; J. William Groves, Esq.; John Mayall, Esq., jun.; *William Thomas Suffolk, Esq.

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—Joseph Beck, Esq., F.R.A.S.; Rev. Edmund Carr, M.A.; Frank R. Cheshire, Esq., F.L.S.; *Edgar M. Crookshank, Esq., M.B.; *Julien Deby, Esq.; G. F. Dowdeswell, Esq., M.A.; James Glaisher, Esq., F.R.S., F.R.A.S.; *Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P., F.L.S.; Urban Pritchard, Esq., M.D.; *Prof. Charles Stewart, M.R.C.S., F.L.S.; Charles Tyler, Esq., F.L.S.

Mr. W. W. Reeves and Mr. J. D. Hardy having been appointed Scrutineers the ballot was proceeded with, and upon the result being subsequently reported to the President, he declared that all the Fellows who had been nominated were duly elected to serve as Council and Officers during the ensuing year.

* Have not held during the preceding year the office for which they are nominated.

The Treasurer's Account was read (p. 356) by Dr. Beale, F.R.S., who said that the office of Treasurer had been one which imposed upon him a very simple, easy, and pleasant duty, the accounts being in a very satisfactory state; he might, indeed, say that it had almost become a sinecure, owing to the careful way in which the books had been kept by their Assistant Secretary, Mr. West. He would only remark that it was to be hoped that all the Fellows of the Society would endeavour to get as many others to join it as possible, as they wanted more funds, which they could use in a very satisfactory manner.

A motion for the adoption of the Treasurer's Report, together with a vote of thanks to him for his services, was moved by Dr. Millar, seconded by Mr. Glaisher, and carried unanimously.

The Report of the Council was read (p. 355).

The adoption of the Report was moved by Mr. Hardingham, seconded by Mr. Guimaraens, and carried unanimously.

The President then read his Annual Address (p. 185), the latter portion being illustrated upon the screen by means of the limelight lantern.

Mr. Glaisher said he rose with great pleasure to propose to the meeting that their best thanks be given to their President for the most admirable address to which they had just been listening. It was an address which had been interesting from beginning to end, opening out as it did so many suggestions for new researches, all of which were well worth following out by those who were able to do so. He did not need to dwell upon the merits of this address, for it was obvious to every one in that room that their President had been working earnestly to elucidate the questions upon which he had touched, and it was sincerely to be hoped that at a future time they would be permitted to hear the results of a continuance of his labours.

Mr. A. D. Michael said they had all known for a long time something of the extreme thoroughness and patience with which Dr. Dallinger carried out his work when engaged in researches such as those which he had described, but he had never known of any example of it more marked than was furnished by the subject of his address that evening. Accidents, such as they had heard of, were unfortunately common to all research, and though they were very depressing when they occurred, it was very gratifying to know that the experiments were not in this case cut short before a very important result had been attained. They were so well acquainted with the great ability and perseverance of the President as to feel quite certain that if human research could do it, the subject would be pursued until a much more important result had been attained. He had much pleasure in seconding the motion.

The motion was then put to the meeting by Mr. Glaisher and carried unanimously.

The President, in acknowledging the vote, said that he had, on his own part, to thank the Fellows for the honour of his re-election, with reference to which he could only say that he would pledge himself to do his very best in the position they had again called upon him to occupy.

Mr. Crisp moved that the thanks of the Society be given to the Scrutineers and Auditors for their services, and Dr. Millar having seconded the motion, it was carried unanimously.

Mr. A. D. Michael thought they could hardly separate without passing a very hearty vote of thanks to their Secretaries for their very laborious and efficient services rendered to the Society during the past year, services which were so well known and appreciated that he was quite sure that such a proposition needed no recommendation from him.

The President said it gave him great pleasure to second this proposal. When they considered all the work which was done, as well as the very efficient way in which it was done, there could be no doubt as to their great indebtedness to the Secretaries for their services.

The motion was then put to the meeting and carried by acclamation.

Prof. Bell returned thanks on behalf of himself and Mr. Crisp.

New Fellows:—The following were elected *Ordinary* Fellows:—Rev. George Southall, and Miss E. C. Jelly. Mr. P. H. Gosse, F.R.S., was elected an *Honorary* Fellow.

REPORT OF THE COUNCIL FOR 1886.

Fellows.—During the year forty-four Fellows have been elected, a number which is a little below the average of preceding years; the deaths, however, have been somewhat exceptional, so that these, added to the resignations and removals, have reduced the list by thirty-three Fellows.

Of the Honorary Fellows, one vacancy has occurred during the year through the lamented decease of Mr. Busk, whose death was noticed by the President at the October meeting. This vacancy has not yet been filled.

The list at the end of last year stood as follows:—617 Ordinary Fellows, 49 Honorary Fellows, and 82 Ex-officio Fellows, or 748 in all.

Finances.—The revenue of the year for interest, admission fees, and annual subscriptions, exceeded 1000*l.* The net increase of annual subscriptions, due to elections of new Fellows, during the year, amounts to 24*l.* 3*s.*, the invested funds standing at the same amount as last year. The arrears of subscriptions are small, and the Council believe that this Society will compare favourably in this respect with any other Society in London.

The compositions received during the year have been applied in part towards payment of the cost of the portraits of the Presidents, which it had been intended to defray out of the invested funds.

Library and Cabinet.—The Council are glad to be able to report that the Catalogue of the Library is in the hands of the printers, and will be issued during the present session.

In going through the books, it was found that there are many which, whilst valuable in themselves, are not, in the opinion of the Council, sufficiently useful or interesting to Fellows of the Society, to make it desirable to retain them, having regard to the fact that the space in the Library is rapidly being exhausted, and that there is but little room to provide for the necessary books to be purchased in future years. Under these circumstances the Council recommend that they should be authorized to dispose of such books as they may consider it undesirable to retain.

The examination of the Cabinet has been continued, and is still in progress. An exhaustive inspection has been made of the slides, and a considerable number have been repaired and otherwise put in order. For this work the Society are largely indebted to Mr. W. T. Suffolk, who has been unremitting in the attention which he has paid to this matter.

THE TREASURER'S ACCOUNT FOR 1886.

Dr.

1886.	£	s.	d.
To Balance brought from 31st December, 1885	189	14	2
„ Interest on Investments	85	16	6
„ Admission Fees	88	4	0
„ Annual Subscriptions	856	2	11
„ Compositions	157	10	0
„ Journals and Reprints sold by Assistant-Secretary	27	18	6
	£1405	6	1

Cr.

1886.	£	s.	d.
By Rent, Gas, and Attendance	95	15	0
„ Salaries, Reporting, and Commission	194	19	6
„ Books and Binding	91	11	9
„ Expenses of Journal	565	8	2
„ Postage of Journal	83	5	9
„ Portraits of Presidents	98	9	3
„ Stationery and Miscellaneous Printing	48	14	4
„ Coffee at Evening Meetings	20	19	0
„ Petty Cash	36	5	0
„ Fire Insurance	1	10	0
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ New Bookshelves	2	10	0
„ King's College Hospital	1	1	0
„ Balance remaining 31st December, 1886	162	15	4
	£1405	6	1

L. S. Beale, *Treasurer.*

Investments, 31st December, 1886.

1200*l.* Freehold Mortgages. 959*l.* 12*s.* 6*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, 25th January, 1887,

Frederick W. Hembry
J. J. Vezey } *Auditors.*

Journal.—It having been found practically impossible to compress the Journal within narrower limits, the Council have consented to an enlargement of the page, so as to give more matter within the same number of pages, and it is hoped that by this means any necessity for an increase in the latter may be obviated. Arrangements have also been made for providing a somewhat thinner paper, so that the bulk of the Journal as a whole will be reduced. The Fellows will understand, however, that the volumes, although apparently smaller that hitherto, contain, in reality, more matter.

The subdivision of the Summary has been carried still further by subordinate headings being given to the Anatomy and Physiology of the Botany section, and also to both divisions of Microscopy, thus facilitating a reference to the notes relating to any given subject.

Meetings.—The interest in the Evening Meetings has been extremely well sustained during the year, the attendance having been larger than in any previous year. The Society are much indebted to the indefatigable exertions of the Secretaries for the subjects brought before the Society, the varied character of which has contributed largely to the interest of the meetings.

MEETING OF 9TH MARCH, 1887, AT KING'S COLLEGE, STRAND, W.C., Mr. W. T. SUFFOLK, VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 9th February last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Bastow, R. A., Mosses of Tasmania, as described in Hooker's Flora of Tasmania, with the addition of forty-three new species from various authors. 64 pp. and 1 table. (8vo, Hobart, 1886) ..	*The Author.*
Castracane, F., Report on the Diatomaceæ collected by H.M.S. 'Challenger' during the years 1873-6. iii. and 178 pp., 30 pls. (4to, London, 1886.)	*Mr. W. T. Thiselton Dyer, C.M.G.*
Slides of *Astrorhiza angulosa* and *Plumularia Wattsii*	*Mr. H. Watts.*

Mr. E. C. Bousfield's note accompanying some photomicrographs exhibited by him was read as follows:—

"The photomicrographs of *Amphipleura pellucida* are not offered as examples of first-rate photomicrographic work, for which mere accuracy of focusing and proper correction of the objective used are by no means sufficient. They will suffice, however, to show what may be expected from the employment of Prof. Abbe's new lenses, and in that respect may prove interesting. The objective employed was a very fine 1/8 apochromatic homogeneous-immersion, N.A. 1·46, projection eye-piece, and the illumination was obtained by a small pencil of very oblique rays from the margin of an Abbe condenser of 1·4 N.A. The illumination of the object, as shown by the darker central portion of the negative, was by no means all that could be desired, but the sharpness of the negative, as testified by the considerable enlargement which it bore, leaves little to be desired, and I hope shortly to be able to bring still more perfect examples

before the Society. Mr. C. Lees Curties effected the resolution of the object; for the remainder I am responsible. The plate used was a Hunter and Sands "Premier," giving about thirty on Warnerke's scale, and the exposure was half-an-hour, though less would probably have sufficed. The light was obtained from a Paragon lamp, using, of course, the edge of the flame.

As an evidence of progress in another direction, perhaps equally important to the photomicrographer, the negatives which accompany the *Amphipleura* specimens may not be without interest. They represent salicine crystals as viewed by polarized light, and the colours were purposely selected to test as severely as possible the capacity of the plate used—a Dixon's orthochromatic. I have employed these plates for such work, with growing satisfaction, for a considerable time. They fail, from exigencies of manufacture and development, at the red end of the spectrum, but even there are far superior to any others with which I have met. The objective used was Zeiss's A, with eye-piece, exposure three minutes or thereabout. Neither negative has been retouched."

Mr. H. Watts's letter was read, accompanying a slide of a rare foraminifer found by him in the Miocene deposits of Victoria, believed to be somewhat unique, as it is the first time it has been found fossil. It was, however, seen on one or two occasions in the 'Challenger' dredgings, but then only two specimens. A second slide sent by Mr. Watts was of the last new species of Marine Hydroida found in Victoria, during 1886, named after the discoverer, *Plumularia Wattsii*.

Dr. Crookshank exhibited two photomicrographs of Flagellated Protozoa in the blood. These photographs were taken with Zeiss's 1/18 homogeneous-immersion from a preparation stained with magenta. The amplification (1750) was obtained by enlargement from the original negatives. They illustrated the employment of the Eastman bromide paper, and the value of photomicrographs for teaching purposes. The flagella and the delicate longitudinal membrane were clearly demonstrated. The negatives were not retouched.

Mr. J. M. Turnbull's sliding nose-piece and adapter, which was awarded a silver medal by the Royal Scottish Society of Arts, was exhibited and described by Mr. Crisp (*supra*, p. 295).

Mr. W. A. Haswell's description of a rotating stage and circular slides for large series of sections was read, and the photographs sent by him exhibited (*supra*, p. 297).

Mr. A. Frazer's centering nose-piece for use with double nose-pieces was exhibited and described by Mr. Crisp (*supra*, p. 294).

Mr. W. Watson exhibited and described the Watson-Draper Microscope, a new instrument which he had made on the designs of Mr. E. T. Draper. The Microscope is an elaboration of the Watson-Crossley form, and the idea of the designer is "that when the object is on the stage, either it may be made to rotate in any direction, horizontal or vertical, round a fixed beam of light without the light ever leaving the object, or

the stage may be kept fixed while the light is revolving round it in any direction horizontal or vertical, always, however, remaining upon the object" (*post*).

Mr. J. Mayall, jun., described the "Nelson Model Microscope," exhibited by Mr. Baker (*supra*, p. 292).

Mr. G. Massee gave a *résumé* of his paper "On the Differentiation of Tissues in Fungi" (*supra*, p. 205).

Mr. A. W. Bennett spoke of the interest attaching to Mr. Massee's paper, inasmuch as so much attention had not been paid to the differentiation of tissues in Fungi as in the higher Algæ, where we often get distinct tissues adapted for assimilation, for conduction, and for strengthening. He did not think, however, that this affected the primary classification of the vegetable kingdom into Cellular and Vascular plants, since it is doubtful whether any true vessels exist in Thallophytes. The cystidia of the Basidiomycetes he did not regard as having any sexual function whatever. They frequently contain large crystals of calcium oxalate.

Professor Stewart said that, although the interest of any structure is naturally greatly enhanced when we are able to recognize the function it performs, we must bear in mind the fact that it may have no duty to accomplish, but be only the result of certain forces acting on the organism, or be but the remains of something of use in past times. Might not the cystidia be produced by the more abundant ascent of fluids through the laticiferous tubes at certain periods, causing an expansion of their free, unsupported extremities; the fluid contents finally escaping either by exuding through the thin walls of the cystidia or producing their rupture?

Drs. H. J. Johnston-Lavis and G. C. J. Vosmaer's paper "On cutting sections of Sponges, and other similar structures with soft and hard tissues," was read by Professor Bell (*supra*, p. 200).

Mr. B. B. Woodward gave some further explanations as to the specimens exhibited in illustration of the paper, which were of exceptionally large size.

Professor Stewart said that large and thin sections of sponges were often of great use by enabling one to determine the natural relationship of distant parts to one another, so that the method described would probably be of chief use in making such sections of the harder sponges. He thought, however, that the simpler freezing method would suffice in most cases. For investigations into the more minute structure, he had obtained the best results by hardening in osmic acid and alcohol, freezing, and cutting with a microtome, and mounting in a solution of acetate of potash, without further staining, or staining with carmine or logwood, and mounting in Canada balsam.

Professor Bell considered that large sections would be found useful in the systematic of sponges, as an assistance to classification.

M. L. Chabry's capillary tube-slide and perforator of cell-elements was similarly exhibited and described (*supra*, p. 319).

Mr. F. Kitton's note on Styrax and Canada Balsam was read as follows:—

"For the last few months I have been using a mixture (equal parts) of

styrax and Canada balsam. The latter was pure, but hardened by exposure to a gentle heat. The styrax ('strained styrax of commerce'), dissolved in benzol and filtered, should be of the consistence of olive oil or a trifle thicker. The refractive index is of course less than that of pure styrax, but higher than that of Canada balsam; it is admirably suited for all the more robust diatoms, from *Eupodiscus argus* to *Pleurosigma angulatum*. It can be hardened over a Bunsen burner without the formation of air-bubbles until it becomes brittle, which, however, is not desirable. Hardening does not materially alter its colour. For the delicately marked diatoms I have found nothing better than tolu. Preparations made two years ago are still free from crystals of cinnamic acid. Prof. H. L. Smith, in the beginning of 1886, kindly sent me some of his own preparations of bromide of antimony in boro-glyceride, together with a score of slides in various other media; many of them were beginning to show crystals; and at this date (December 13th, 1886) the diatoms are obscured by dense crystals. The slides prepared by myself with his bromide of antimony and boro-glyceride, the covers cemented with litharge and red-lead mixed with gold size (the most durable of all cements—I have some insect preparations, mounted in cells 1/12 in. deep filled with dilute glycerin and spirit, as perfect as they were when first mounted twenty-five years ago), are all full of crystals and perfectly useless. This is much to be regretted as in every other respect this medium left nothing to be desired. With a dry 1/6 in. of Ross the lines on *Surirella gemma* were easily resolved into dots, and those on *P. angulatum* could be seen with an old Ross 1/4 in. of 74°. I have several of Dr. Meates' sulphide of arsenic mounts, but they are spoilt by crystallization."

The following Instruments, Objects, &c., were exhibited:—

Mr. C. Baker:—Nelson Model Microscope.

Mr. Bolton:—*Pedicellina cernua* var *glabra*.

Mr. E. C. Bousfield:—Photomicrographs of *Amphipleura pellucida* and Salicine Crystals.

Mr. Crisp:—(1) Turnbull's Sliding Nose-piece and Adapter; (2) Frazer's Centering Nose-piece; (3) Chabry's Capillary Tube-slide.

Dr. Crookshank:—Photomicrographs of flagellated Protozoa in the blood.

Drs. H. J. Johnston-Lavis, and G. C. J. Vosmaer:—Sections of sponges in illustration of their paper.

Mr. W. Watson:—New Microscope designed by Mr. E. T. Draper.

Mr. H. Watts:—Slides of *Astrorhiza angulosa* and *Plumularia Wattsii*.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. E. B. L. Brayley, W. Lynd, W. Stratford, M.D., A. E. Weightman, Surg. R.N., H. Weld-Blundell, R. Henslowe Wellington, and W. P. Young.

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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

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One of the Secretaries of the Society

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

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FELLOWS OF THE SOCIETY.

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(3) Secretions.

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I.—APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power ($\frac{1}{a}$)
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\ \mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\ \mu$, near Line *h*.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·65
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·66
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·66
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·67
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·67
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·68
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·68
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·69
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·69
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·69
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·70
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·70
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·71
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·71
1·38	..	..	130° 26′	133,046	144,215	175,257	1·904	·72
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·73
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·73
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·74
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·74
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·75
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·75
1·31	..	160° 6′	119° 3′	126,297	136,899	166,367	1·716	·76
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·76
1·29	..	151° 50′	116° 8′	124,369	134,809	163,827	1·664	·77
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·78
1·27	..	145° 27′	113° 21′	122,441	132,719	161,287	1·613	·78
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·79
1·25	..	140° 3′	110° 39′	120,513	130,629	158,747	1·563	·80
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·80
1·23	..	135° 17′	108° 2′	118,584	128,539	156,207	1·513	·81
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·82
1·21	..	130° 57′	105° 30′	116,656	126,449	153,668	1·464	·82
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·83
1·19	..	126° 58′	103° 2′	114,728	124,359	151,128	1·416	·84
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·84
1·17	..	123° 13′	100° 38′	112,799	122,269	148,588	1·369	·85
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·86
1·15	..	119° 41′	98° 20′	110,872	120,179	146,048	1·323	·87
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·87
1·13	..	116° 20′	96° 2′	108,943	118,089	143,508	1·277	·88
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·89
1·11	..	113° 9′	93° 47′	107,015	115,999	140,968	1·232	·90
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·90
1·09	..	110° 5′	91° 38′	105,087	113,909	138,428	1·188	·91
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·92
1·07	..	107° 8′	89° 30′	103,159	111,819	135,888	1·145	·93
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·94
1·05	..	104° 16′	87° 24′	101,231	109,729	133,348	1·103	·95
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·96
1·03	..	101° 30′	85° 19′	99,302	107,639	130,808	1·061	·97
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·98
1·01	..	98° 50′	83° 17′	97,374	105,548	128,268	1·020	·99
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·00
0·99	163° 48′	96° 12′	81° 17′	95,446	103,458	125,728	·980	1·01
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·02
0·97	151° 52′	93° 40′	79° 18′	93,518	101,368	123,188	·941	1·03
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·04
0·95	143° 36′	91° 10′	77° 22′	91,590	99,278	120,648	·903	1·05
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·06
0·93	136° 52′	88° 44′	75° 27′	89,661	97,188	118,108	·865	1·07
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·08
0·91	131° 0′	86° 20′	73° 33′	87,733	95,098	115,568	·828	1·09
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·11
0·89	125° 45′	84° 0′	71° 40′	85,805	93,008	113,028	·792	1·12
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·13

APERTURE TABLE—*continued.*

Numerical Aperture. ($\sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1{\cdot}00$).	*Water* ($n = 1{\cdot}33$).	*Homogeneous Immersion* ($n = 1{\cdot}52$).	White Light. ($\lambda = 0{\cdot}5269\,\mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0{\cdot}4861\,\mu$, Line F.)	Photography. ($\lambda = 0{\cdot}4000\,\mu$ near Line *h*.)		
0·87	120° 55′	81° 42′	69° 49′	83,877	90,918	110,488	·757	1·149
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·85	116° 25′	79° 37′	68° 0′	81,949	88,828	107,948	·723	1·176
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·83	112° 12′	77° 14′	66° 12′	80,020	86,738	105,408	·689	1·205
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·81	108° 10′	75° 3′	64° 24′	78,092	84,648	102,868	·656	1·235
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·79	104° 22′	72° 53′	62° 38′	76,164	82,558	100,328	·624	1·266
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·77	100° 42′	70° 45′	60° 52′	74,236	80,468	97,788	·593	1·299
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·75	97° 11′	68° 40′	59° 8′	72,308	78,378	95,248	·563	1·333
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·73	93° 46′	66° 34′	57° 24′	70,379	76,288	92,709	·533	1·370
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·71	90° 28′	64° 32′	55° 41′	68,451	74,197	90,169	·504	1·408
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·69	87° 16′	62° 30′	53° 59′	66,523	72,107	87,629	·476	1·449
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·67	84° 8′	60° 30′	52° 18′	64,595	70,017	85,089	·449	1·493
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·65	81° 6′	58° 30′	50° 38′	62,667	67,927	82,549	·423	1·538
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·63	78° 6′	56° 32′	48° 58′	60,738	65,837	80,009	·397	1·587
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·61	75° 10′	54° 36′	47° 19′	58,810	63,747	77,469	·372	1·639
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·59	72° 18′	52° 40′	45° 40′	56,881	61,657	74,929	·348	1·695
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·57	69° 30′	50° 45′	44° 2′	54,954	59,567	72,389	·325	1·754
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·55	66° 44′	49° 51′	42° 25′	53,026	57,477	69,849	·303	1·818
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·53	64° 0′	46° 58′	40° 48′	51,097	55,387	67,309	·281	1·887
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·51	61° 20′	45° 6′	39° 12′	49,169	53,297	64,769	·260	1·961
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·48	57° 22′	42° 18′	36° 49′	46,277	50,162	60,959	·230	2·083
0·46	54° 47′	40° 28′	35° 15′	44,349	48,072	58,419	·212	2·174
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·44	52° 13′	38° 38′	33° 40′	42,420	45,981	55,879	·194	2·273
0·42	49° 40′	36° 49′	32° 5′	40,492	43,891	53,339	·176	2·381
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·38	44° 40′	33° 12′	28° 57′	36,636	39,711	48,259	·144	2·632
0·36	42° 12′	31° 24′	27° 24′	34,708	37,621	45,719	·130	2·778
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·34	39° 44′	29° 37′	25° 51′	32,779	35,531	43,179	·116	2·911
0·32	37° 20′	27° 51′	24° 18′	30,851	33,441	40,639	·102	3·125
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·28	32° 32′	24° 18′	21° 14′	26,995	29,261	35,559	·078	3·571
0·26	30° 10′	22° 33′	19° 42′	25,067	27,171	33,019	·068	3·846
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·24	27° 46′	20° 48′	18° 10′	23,138	25,081	30,479	·058	4·167
0·22	25° 26′	19° 2′	16° 38′	21,210	22,991	27,940	·048	4·545
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·18	20° 44′	15° 34′	13° 36′	17,354	18,811	22,860	·032	5·555
0·16	18° 24′	13° 50′	12° 5′	15,426	16,721	20,320	·026	6·250
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·14	16° 5′	12° 6′	10° 34′	13,498	14,630	17,780	·020	7·143
0·12	13° 47′	10° 22′	9° 4′	11,570	12,540	15,240	·014	8·333
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·08	9° 11′	6° 54′	6° 3′	7,713	8,360	10,160	·006	12·500
0·06	6° 53′	5° 10′	4° 32′	5,785	6,270	7,620	·004	16·667
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

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104	2 inches	17	2 10 0	22	36	67	90	112
105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0					
107	⅔ inch	32	2 10 0	70	112	210	280	350
108	½ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4 10 0	250	400	750	1000	1250
113	$\frac{1}{6}$ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
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151	2 inches	8	1 0 0	18	23	41
152	1 inch	18	1 5 0	46	61	106
153	½ inch	38	1 5 0	90	116	205
154	¼ inch	80	1 5 0	170	220	415
155	$\frac{1}{6}$ inch	110	2 5 0	250	330	630
156	$\frac{1}{8}$ inch	110	3 10 0	350	450	800
157	$\frac{1}{15}$ imm.	180	6 0 0	654	844	1500

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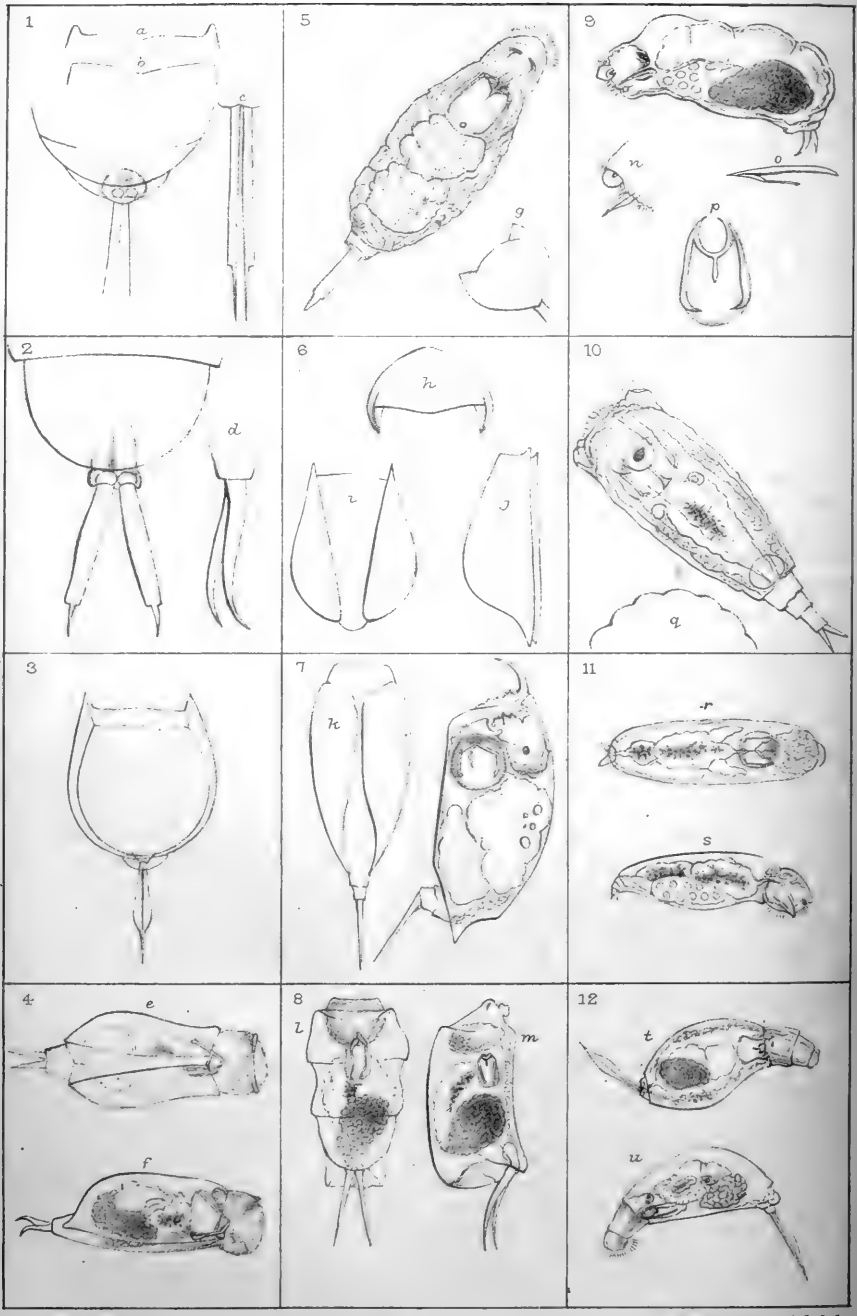

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New Rotifera.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1887.

TRANSACTIONS OF THE SOCIETY.

VIII.—*Twelve New Species of Rotifera.*

By P. H. Gosse, F.R.S., Hon. F.R.M.S., &c.

(*Read 13th April*, 1887.)

Plate VIII.

I beg to add diagnoses and figures of a few more Rotifera, supplementary to those described in this Journal, *ante*, p. 1.

1. *Cathypna angulata.* Generally, like *C. luna*, but occipital edge of lorica nearly straight; pectoral edge indented in the middle: toe rod-shaped, straight, very slender; claw one-shouldered, one-third of toe's length. Length, total, 1/85 in. Lacustrine.

This is more than twice as large as *C. luna*. Moreover, the frontal edges of the lorica are nearly *straight*, between very slight lateral points, and *alike*, save that the line of the pectoral edge (fig. 1, *b*) descends from each point to a medial angle, just perceptible. Then, the hind extremity of the dorsal plate allows the partial emission of a great protuberant shelly boss, as in *Monostyla bulla*, behind and beneath which is the globose foot-bulb. Again, the rod-like toes are even straighter and slenderer than in *luna*, and the claws are much longer in proportion. Parallel-edged to two-thirds of their length, a right-angled shoulder, on the outer side, reduces the width by one-half; and the remainder (the claw) tapers to a long-drawn acute point (*c*). When rotating, the truncate front is three-lobed, much as in *luna;* but there is seen beyond and above this a very subtile clear glassy hood, having a rondo-conic outline, protrusile and retractile.

EXPLANATION OF PLATE VIII.

Fig. 1.—*Cathypna ungulata;* hind end of lorica. *a*, occipital edge; *b*, pectoral edge; *c*, toes.
Fig. 2.—*Cathypna diomis;* foot and toes, dorsal; *d*, toes, seen from the *left*.
„ 3.—*Cathypna latifrons;* dorsal.
„ 4.—*Diaschiza globata;* *e*, dorsal; *f*, lateral.
„ 5.—*Monostyla mollis;* dorsal; *g*, contracted.
„ 6.—*Dapidia stroma*, lorica; *h*, transverse section; *i*, ventral; *j*, lateral.
„ 7.—*Colurus leptus;* lateral; *k*, ventral outline.
„ 8.—*Diglena* (?) *pachida;* *l*, dorsal; *m*, lateral.
„ 9.—*Diglena suilla;* lateral; *n*, jaws protruded; *o*, jaws, lateral; *p*, jaws, dorsal.
„ 10.—*Notommata potamis;* dorsal; *q*, transverse section of back.
„ 11.—*Proales othodon;* *r*, dorsal; *s*, lateral.
„ 12.—*Proales prehensor;* *t*, dorsal; *u*, lateral.

I have seen this form only from Woolston Pond, and only on one occasion. (Plate VIII. fig. 1.)

2. *Cathypna diomis.* Generally, like *C. luna*, but lorica much elevated behind, and ending there abruptly; followed by a wide hemispheric joint: toes slightly blade-shaped; claw two-shouldered, short, recurved. Length of lorica 1/260 in.; total, expanded, 1/150 in. Lacustrine.

A rather remarkable little form. The carapace, broadly ovate, is unusually arched, and abruptly truncate just behind its greatest elevation; whence another wide rounded plate descends, as if to make the carapace two-jointed.* The foot, narrow, but a little widened at its end, just protrudes from under this plate, and bears the toes, jointed to it with small round condyles. They are almost rod-shaped, but there is a hardly perceptible curvature of their lateral margins. But the most noteworthy feature is that *both* the lateral margins of each toe are abruptly shouldered; and the little claw-like remainder has the acute tip recurved (*d*). The mallei are long, strongly elbowed, and unusually slender. An eye, of moderate size, richly coloured, lies far down in the occiput. The dorsal plate is coarsely tesselated, as in *C. rusticula*. Several specimens have occurred in water sent to me by Mr. Hood, from Black Loch, near Dundee. (Fig. 2.)

3. *Cathypna latifrons.* Lorica broadly ovate, the frontal edges little diminished, both straight; the occipital much wider than the pectoral: toes broadly blade-shaped, much produced, not shouldered. Length of lorica 1/260 in. Lacustrine.

Another of the rarities of the prolific Black Loch. The outline is that of *C. rusticula*, if we suppose the anterior fourth of the lorica to be cut off transversely. But the ventral plate is less in area, *all round*, than the dorsal, especially forward, narrowing more rapidly, and terminating lower down. There is a considerable rounded boss behind, as in both the preceding, below (or within) which are the foot-joints, but not protruded. The toes have the inner edge straight, and the outer *much* outcurved; so that, when they are held in contact (as they usually are), the pair present an outline widely fusiform. Then the points are drawn out to great length and tenuity, with an effect very peculiar. The front of the lorica forms two stiff lateral points; within which the margins, both occipital and pectoral, seem to be thinned-off to very delicate membranes, so as to be capable of extension and retraction. When closed, the occipital edge is, I think, straight from point to point, and concave inward. Then the pectoral edge is appressed to the concave dorsal surface (*but at a lower*, i. e. *a hinder, level*); and that so close as to be indistinguishable from it, even by most careful focusing with high powers. The internal organs seem normal. (Fig. 3.)

4. *Diaschiza globata.* Body sub-pyriform, becoming globose in contraction: front round, girded by a prominent ring: lorica dorsally cleft by a wide, but shallow furrow, whose edges rise to slight ridges: foot stout; toes slender, produced, acute, slightly decurved. Length 1/200 in. Lacustrine.

The shallow dorsal cleft, having a V-shaped section, is well seen, as

* This represents the "shelly boss" of the preceding species, and may possibly be, structurally considered, the basal joint of the foot abnormally developed.

the creature crawls about the weeds, the edges turned up slightly; while the sides of the lorica end ventrally in straight lines, produced behind into small obtuse points. The integument appears sometimes quite flexible. The bluff rounded head, clothed with simple cilia, is surrounded by a prominent ring or collar, not always observable. An occipital brain seems destitute of any eye-spot. The toes are delicately attenuated to long points, which, *more generis*, are often thrown back, though the points are decurved.

The little animal is active and restless, moderately swift in swimming, with frequent augmentations of speed, sudden and sustained. It soon dies in a *live-box*; and, in dying, usually contracts itself into a globular form. Sometimes it spins swiftly round and round, in a circle of which the toe-tips are the centre. I have examined some eight or ten specimens, all in water sent by Mr. Hood from his aquarium at Dundee. (Fig. 4.)

5. *Monostyla mollis.* Body oblong, sub-cylindric, clothed with a soft, flexible, corrugated skin, instead of a lorica: toe rod-shaped, short, thick; claw obscurely two-shouldered. Length 1/250 to 1/200 in. Lacustrine.

I venture to claim specific rank for this form, which has the same relation to *Monostyla* as *D. flexilis* has to *Distyla* and *Cathypna*. That both are immature conditions would be a natural conclusion, but that, so far as my experience goes, all Loricate Rotifera are hatched with the lorica already developed. And that such is the case with *Monostyla* in particular, the following note will show. The facts, apart from their relation to this question, may be of interest.

In August 1885, an egg of *M. cornuta*, in my live-box, displayed the young moving vigorously within the hyaline egg-shell, slowly revolving. The lorica was already well defined, evidently without folds, though expansile in retraction, distinctly broad-oval in outline, smooth and rotund when viewed lengthwise. The imprisoned animal grew much larger, so that it almost filled the long diameter of the shell, but not nearly its short diameter. Its length was now 1/400 in.

After I had watched for about an hour, during which its restless motions had nearly ceased, the frontal cilia were seen vibrating at the very edge, and in a moment more *outside* the edge, of the shell. For an instant it recoiled; but returned again and again to the effort, at each time protruding more and more. At length it pushed fully half out, then hung a moment, as if exhausted. Now another vigorous lashing of the cilia, and out it is bodily, yet still adhering to the shell by the glutinous toe-point, whereby it now drags the shell hither and thither. At last it is quite free, evidently ovate, stiff and smooth, as the normal adult.

These facts, which were recorded during the actual process, seem sufficient to show that, in this Family at least, the chitinous consolidation of the lorica is attained before birth. And the corollary follows, that, in *D. flexilis* and *M. mollis* we have examples of illoricate condition in a loricate family, analogous to *Mastigocerca stylata* in the *Rattulidæ*.

I have examined many specimens from various waters. In one case the animal contracted to a cordiform outline *g*, as if possessing a

lorica, which yet was very membranous. When eagerly chewing, not only the mallei worked, but a pair of additional horn-like pieces, well in front of the mastax. A very small and indistinct red eye is near the occipital extremity of the brain. (Fig. 5.)

6. *Dapidia stroma.* Outline ovate, dorsum high, rounded: carapace much exceeding the viscera in width, and turned-in beneath with straight margins; viscera protected exclusively by membrane. Length 1/65 in. Lacustrine.

Dr. Hudson (Rotifera, ii. 89) has alluded to my opinion that certain species of *Euchlanis* are generically separable by the character of wanting a ventral plate; the lateral edges of the carapace, which turn in beneath, being united only by flexible and expansible skin. My esteemed colleague differs from me; and, on a matter so exceedingly delicate and difficult to determine, I may be in the wrong. But I am not convinced; and I hope it is not inconsistent with modesty or friendship to record my own judgment. The *species*, I think, is undescribed, whatever its generic place.

The carapace is shaped (if I may use so homely a comparison) like a boat turned bottom up, her bows cut off sharp, her gunwale curved-in, and no keel. Suppose the cavity of the boat to be loaded, *half-way up*, with goods [the viscera], and a tarpaulin [the common skin] to be spread over all, but higher in the middle than at the sides; the head-mass, of living fleshy organs, to be thrust out at the truncate and open bow, filling it; and the foot and toes to represent the rudder;—a fair idea will be conceived of this fine form. There are no foot-setæ.

It may easily be supposed to possess a ventral plate. But what looks like one, on a (nearly) lateral view, is the edge of the farther incurved side of the carapace; when viewed *from behind*, there is no lateral infold or sinus running longitudinally. I have seen numerous examples. (Fig. 6.)

7. *Colurus leptus.* Lorica, in dorsal aspect, long oval; in lateral aspect, abruptly excavate behind; dorsal hind points, acute: ventral cleft close, insensibly expanding to a long pyriform foot-orifice: toe a slender style, apparently undivided; foot and toe about half as long as lorica: one large eye in occiput. Length, extended, 1/300 in. Lacustrine *and marine.*

A marked character, very easily recognizable, is the hind excavation of the lorica, as if a slice had been cut clean out. Examples with this peculiarity are quite common, both from weedy fresh waters, and from rock-pools on our northern and southern coasts. And I can trace no difference between them, save that the marine examples may be a trifle stouter in outline. The toe is a slender produced point, I will not say indivisible, but not, in my experience, divided. Several oil-globules are usually present in the dorsal part of the visceral cavity. (Fig. 7.)

8. *Diglena* (?) *pachida.* Body thick, sub-cylindric, very variable in outline: skin leathery, thrown into strong folds: eye wanting: toes two, furcate, long, slender, acute, decurved. Length 1/87 in. Marine.

Several examples of this curious thickset form,—more remarkable than attractive,—occurred to me last summer, in sea-water from various rock-pools in Torbay. It is uncouth, heavy and sluggish, apparently

illoricate, but inclosed in integument which seems of leathery stiffness, making stout, transverse folds, whence the fore and hind parts project at intervals. The head, at extreme protrusion, shows a thread-like frontal proboscis, an ample brain, but no eye, and trophi which appear slight and very simple, but need further examination. The toes, long and slender, have that backward direction which is seen in many *Diglenæ*, yet have a forward curve. The internal organs are nearly lost in an indistinguishable granulation.

Its generic affinities are very doubtful. It is not improbable that a more matured acquaintance may elevate this strange form to the rank of a genus. In any case it is a notable addition to our marine Rotifera. (Fig. 8.)

9. *Diglena suilla.* Body cylindric, or fusiform, massive, often gibbous in the middle: face broad, sub-prone, with small, tubercular frontal proboscis: eye large, cervical: foot thick, short: toes minute, decurved. Length 1/200 in. Marine.

This thick-bodied, plump, snouted, swine-like creature occurred in a number of examples, among conferva much crowded with groups of diatoms, in sea-water from Invergowrie. The body rises into successive swellings, divided by sharp constrictions, like that of a full-fed caterpillar, diminishing abruptly to an oblique thick head, with a distinct round pimple in front, in which is a very minute refractive corpuscle, like a glass bead. This, however, is probably not an eye, the true eye being large and conspicuous, near the tip of an ample brain. The front is truncate, but appears semi-prone, from the inclination of the head; it is ciliated on its whole surface, the cilia *surrounding* the globose proboscis, not *covering* it. The jaws (*o p*) are of the same form as in other *Diglenæ*, as *permollis;* viewed laterally, they are produced into a long point, which is often deliberately projected (*n*) and retracted. Young specimens lack the plumpness of adults, especially in the hinder parts. The stomach is of great size, usually gorged with green granular food. The animal, in habit, is very sluggish. (Fig. 9.)

10. *Notommata potamis.* Of large size, sub-cylindric, gradually tapering to the foot: brain clear, obscurely three-lobed: head broad, with conspicuous *oblique* auricles: trunk strongly fluted: foot long: toes short, pointed. Length 1/90 in. Lacustrine.

Having much in common with *N. naias*, both in general form and in details, this presents characters which appear to mark it as specifically distinct. In more than a dozen examples which I have examined, alive and dead, from Woolston Pond and other waters, these distinctive features were seen. The auricles are large and strongly marked, extruded freely, and so remaining even in death, having the form, not of *hemispheres*, but of short truncate *columns*, thrust out *obliquely*, so as to make the whole head obconic. A great clear brain shows a tendency to triplicity; the middle sac bears a conspicuous red eye on its inner surface, above its swelling. The whole body is fluted strongly, about twelve deep incisions running longitudinally throughout, so that a transverse section would show so many rounded elevations (*q*). The stomach has a pair of minute ovate glands, is very large and saccate, with a distinct intestine. The last joint of the trunk forms a globose saccate sort of tail, over

and behind the first joint of the foot, not unlike that of *Copeus pachyurus*. The branchial system displays thick convolute vessels and a small contractile bladder. The whole animal, in life, is often tinged with delicate yellow, of deeper hue in the stomach. Several specimens which seem to belong to this species, recently obtained (April 1887) from a pond near my residence, have the head of an orange hue, the front half of the mastax of a transparent crimson, and the eye of a rich ruby-red; the whole giving a most attractive appearance to the animal, which is, moreover, very vivacious in manner. (Fig. 10.)

11. *Proales othodon.* Body nearly cylindric, but arched in the line of the back, straight in that of the belly; very plump throughout: mastax forcibly protrusile: foot and toes minute. Length 1/144 in. Lacustrine.

This also occurred in water from Woolston—a single example only. It is of plump hog-like form, without wrinkles, and almost without folds. It has no very marked characteristics, yet it does not seem referrible to any recognized species. There is a slight projection from the front in a lateral view (*s*), which, however, in a dorsal view (*r*) appears to be a wide ridge seen endwise. The face is obliquely prone, from the midst of which the jaws are occasionally protruded, with force, in the manner of a fierce *Diglena:* the details of these jaws I was not able to trace. A sac-like brain is conspicuous, but I could discern no eye. The stomach and distinct intestine are ample; the former carries a pair of gastric glands, which are large, high, and pointed. (Fig. 11.)

12. *Proales prehensor.* Body bottle- or oil-flask-shaped, but with the belly nearly flat; fore parts long, very protrusile; eye small; face prone: a short tuberculous tail: foot short; toes blade-shaped, straight, acute, usually appressed. Length 1/173 in. Lacustrine.

I have doubts where I should place this species. Technically, it seems a *Notommata* or *Proales*, with the form of a *Distyla*, yet having much in common with *Distemma*. The toes, in particular (see *t*),—blades, widest in the middle, with slender produced tips, and generally carried close together as one (though sometimes widely spread),—remind us forcibly of *Distyla* or *Cathypna*. The trophi, too, suggest the same alliance: viewed ventrally, the length and form of the mallei, and the triradiate incus, for instance:—yet I believe I have seen a great blade-like prolongation of the incus arching far into the occiput; and, at times, what seemed a short forcipate form of the rami, as in *Diglena* and *Distemma*. There appears a sort of proboscis, but close appressed, not at all movable. I have never seen the jaws protruded, though they are every moment brought to the bottom of the ciliate face, snapping up atoms of food.

It is not much given to locomotion, but can swim, rather slowly: usually, it rolls hither and thither, or adheres by the toes. It picks industriously among the vegetable floccose for morsels of food: it is vivacious and energetic, and altogether attractive; constantly reminding me of the marine *Distemma raptor*. I have observed, in all, about a score of examples, all isolated, in water courteously sent me by Miss Davies, from Woolston Pond. (Fig. 12.)

Corrigenda et addenda.

Monura micromela, Gosse (this Journal, *ante* p. 7). Since this was published I have seen the toes widely expanded. The species must, therefore, be transferred to *Colurus*.

Furcularia marina, Duj. (H. & G. Rotif., ii. 44). I have lately seen two pectoral eyes, pale-red, well-defined, one on each side of (but behind) the mastax. The species must, therefore, be transferred to *Distemma*, with which genus the trophi agree.

Triophthalmus dorsualis, Ehr., a noble species, I have lately found in a pool near my own residence, agreeing accurately with Ehrenberg's figure.

Anuræa 4-*dentata*, Ehr. I have identified in water sent me by Mr. Bolton from Birmingham.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Mechanism of Development.‡—Dr. W. Roux continues his researches on the mechanics of embryonic development. The present contribution, which is the fourth of the series, is specially devoted to the investigation of the manner in which the disposition of the median plane of the frog embryo is determined by the direction of conjugation of male and female nucleus.

(*a*) In normal conditions, when the ovum is unconstrained and when it has not been altered by too long delayed spawning. (1) The unfertilized ovum has only one main direction of the future median plane of the embryo determined—by the bipolar arrangement of the yolk-material. The axis from black to white pole represents the dorso-ventral direction of the real, the cephalo-caudal direction of the final embryo. (2) Of the meridian planes through this egg-axis, that in which the two nuclei conjugate becomes the median plane of the embryo. (3) But the direction of conjugation is not fixed, but may be displaced by "localized fertilization" to any meridian. (4) The fertilized side of the ovum becomes the ventro-caudal side of the embryo, the other the dorso-cephalic.

(5) The first division of the segmentation nucleus occurs in the direction of conjugation. The separation of the two halves takes place at right angles to the direction of division. (6) The coincidence of the direction of conjugation and plane of division has this functional import, that only in this case is the effect of conjugation subject to no miscarriage by the division. It expresses the simplest mechanism of the division of masses united, but not completely mixed in conjugation. (7) The first yolk division occurs in the meridional plane parallel to the direction of conjugation, and eventually coinciding with it. (8) The direction of conjugation determines the direction of the first segmentation of the nucleus, that the first yolk-division, and eventually the disposition of the embryo in the egg.

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

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

‡ Arch. f. Mikr. Anat., xxix. (1887) pp. 157–212 (1 pl.).

(9) The process of conjugation exhibits two typical intraoval courses, first an approximately radial course which leads the sperm from the point of penetration on the black margin, deep into the ovum, to the "nuclear layer" of the yolk, and second, a nucleopetal course which conducts the two nuclei towards one another within the "nuclear layer," but especially the sperm nucleus to the female.

(*b*) When the ovum is forcibly fixed with the axis oblique. (10) If the inclination be but slight (20–30°), the above statements often hold good. (11) The yolk-material is disposed in such a way that it lies symmetrically in relation to the first plane of division determined by the direction of conjugation. (12) If the inclination be greater, the influence of gravity on the yolk produces a symmetrical disposition of the different material, and this influences the first division in such a way that the plane of division is definitely disposed to the plane of symmetry, either lying in it or at right angles to it. (13) Here also the first nuclear division apparently occurs in the direction of the conjugation of the nuclei. (14) The position of the germinal vesicle is influenced by the obliquity of the axis, and the course of the sperm by the streaming of the yolk in such a way that the conjugation must often occur in a direction approximately transverse to the plane of symmetry in the oblique ovum. Thus there results a frequent approximately transverse direction of the first segmentation. (15) But since the first segmentation is most frequently either quite transverse to the plane of symmetry or exactly in the same direction, it is necessary to suppose a twisting action of the symmetrically disposed yolk on the segmentation nucleus, during or after conjugation. This turning may be supposed to occur so that the segmentation nucleus and its direction of conjugation become either parallel or perpendicular to the plane of symmetry, according as the line of conjugation is nearer one or other. (16) If the segmentation nucleus and line of conjugation be turned into the plane of yolk symmetry, the first nuclear division separates the material of the two antimeres of the embryo, and the first plane of yolk division is the median plane of the embryo. (17) If the turning result in a position perpendicular to the above, the first nuclear division separates the nuclear material, as in a normal second segmentation, into what ultimately become ventrocaudal and dorsocephalic portions. (18) With greater obliquity of egg axis the side of the depressed black pole becomes always the ventrocaudal side of the embryo. With slight obliquity this tendency may conflict with that determined by the position of fertilization (cf. 4 and 8), and the fertilized side become the ventrocaudal, but this is only if the rearrangement of the yolk occur in such a way that, at the time of second segmentation, the egg axis has its black pole inclined towards the sperm. (19) The primary cause for the position of the ventrocaudal surface on the side to which the upper end of the egg axis is inclined is probably the accumulation of formative yolk on that side.

Origin of Segmental Duct.* — Prof. A. C. Haddon summarizes the history of the discovery of the epiblastic origin of the primitive duct of the vertebrate excretory organ, and alludes to the difficulties which have hitherto beset the interpretation of its morphology.

Accepting the proposition that in primitive Chordata the nephridia were segmentally arranged and opened directly to the exterior, we have only to assume that the lateral area along which they opened was grooved and that this groove extended posteriorly as far as the anus. From the analogy of the neural groove, there is no great difficulty in further supposing that the

* Proc. R. Dublin Soc., v. (1887) pp. 463–72 (1 pl.).

nephric groove was converted into a canal, which, becoming separated from the overlying epiblast, might sink into the deeper-lying parts of the body. We are justified in assuming the persistence of the blastopore as the anus in early Chordata; thus, if the nephric groove were continued round to the anus, it would practically open into the extreme hinder end of the mesenteron, in other words into the urodæum (Gadow). Probably about the same time that the nephric groove was being converted into the nephric canal (segmental duct) the proctodæum was being invaginated. The latter would push before it the posterior orifice of the nephric canal. The nephridia themselves appear to be of mesoblastic origin. On the hypothesis just sketched out, the nephridia always open by their original epiblastic pores—primitively, directly to the exterior; secondarily, into a canal separated from the epiblast: also the archinephros could be equally effectively functional throughout the whole period of its modification.

Embryogeny of Anthropoid Apes.*—Dr. J. Deniker has been able to study the fœtus of the gorilla and the gibbon, which he compares with that of man. Especial attention is given to the proportions of the limbs, and it is shown that while in man, during the earlier stages of embryonic life, the lengths of both extremities are almost equal, in the anthropoid apes, at even an early period, the length of the upper exceeds that of the lower limb. The frontal region of the skull ossifies more rapidly, and the occipital and petromastoid portions more slowly in anthropoid apes than in man. The encephalon of the fœtal gorilla weighed 28 grammes, or one sixteenth of the weight of the whole body; in both fœtûs the cerebellum was very small and completely covered by the cerebrum. The relative and absolute dimensions of the brain of the fœtal gorilla correspond to those of the human fœtus at the fifth month, but in its convolutions it was equivalent to those of the human fœtus at the sixth month. The dentary follicles of both gorilla and gibbon are developed earlier than in man; in the gorilla the teeth of the upper appear before those of the lower jaw, or in the reverse order to what ordinarily obtains in man. The cæcal appendage appears to increase relatively to age in the gorilla, while the contrary is the rule in man.

Segmentation of Frog Ova in Sublimate Solution.†—Herr T. Dewitz, in reference to a report by Tichomiroff as to parthenogenesis artificially induced in the eggs of *Bombus* by mechanical and chemical irritation, notes that he observed unfertilized frog ova to undergo segmentation in sublimate solution. In some cases one segmentation has occurred, in others several; in some cases irregularly, in others normally. The ova experimented on were those of *Rana fusca*, *R. esculenta*, and *Hyla arborea*. The segmentation occurred alike when the ova were left in the solution, or simply dipped in it for a few minutes and then put into water. In the latter case the segmentation became slowly evident, so that the suggestion of its having been preformed is not adequate. No spontaneous segmentation has been observed, so that if the observations be correct the sublimate acts as a stimulus.

Hybridization between Amphibia.‡—Prof. G. Born has continued his researches on the hybridization of Amphibia, and after a long series of experiments has reached a number of interesting results.

(1) Crossing is possible in many cases, in three cases reciprocally. The

* 'Recherches anatomiques et embryologiques sur les Singes Anthropoïdes,' Paris, 1885. See Nature, xxxv. (1887) pp. 509–10.

† Biol. Centralbl., vii. (1887) pp. 93–4.

‡ Arch. f. Mikr. Anat., xxvii. (1886) pp. 192–271 (3 pls.).

degree of development reached by the hybrid fertilized ova varied greatly. Fertilization was sometimes effected without any result. In other cases the ova reached the stage of segmentation, and that to a varying extent. A third degree was exhibited by those which survived till the closure of the blastopore. When this was so the preceding segmentation was perfectly regular. Many larvæ die soon after liberation, a few survive.

(2) In hybridization between *Rana fusca* m. and *R. arvalis* f., and between *Bufo variabilis* m. and *B. cinereus* f., the larvæ survived metamorphosis; in the latter the hybridization is readily successful, in the former only in a small minority of cases.

(3) In amphibians hybrid fertilization occurs most readily when the reproductive elements of both sexes are in perfect maturity. The sperm retains its potentiality only a very short time in relation to the ova of some species, for a very long time in relation to those of others. These conclusions are compared with those of Pflüger and Hertwig.

(4) The result of hybrid fertilization between *R. fusca* m. and *R. arvalis* f. depends greatly on the concentration of the sperm-fluid. The more dilute, the fewer sperms are there to overcome the difficulties of effecting entrance. Probably, too, the sperms have lost some of their energy. The obverse statement that the more concentrated the sperm-fluid, the more spermatozoa should enter the ovum, was beautifully verified by direct observation. Born has proved that the presence of more than one sperm-nucleus within the ovum is usually at the greatest hazard of normal development. All the more marked irregularities in hybridization are referable to polyspermy; when regular and simple segmentation and development have occurred, it may be conversely inferred that only one spermatozoon has entered. As in normal fertilization, the ova have the power of refusing sperms after one has entered. In most cases, after a certain stage is passed, the divergent tendencies of ovum and sperm seem no longer organically compatible, and a paralysis of development ensues. Life and continued development are coincident.

(5) It is difficult to determine whether cases of successful development after hybrid fertilization occur normally. *Bufo variabilis* m. and *Bufo cinereus* f. are often found copulating, but the result is only known to be successful in the above artificial experiments.

The research closes with some notes on the manifold obstacles to successful hybridization, on hybridization in general, and on the suggestiveness of such inquiries as to the pathology of reproduction in relation to the normal processes.

Origin of Periblast in Teleosteans.*—Dr. J. H. List reports the results of some observations made in 1884 on the formation of the periblast in *Crenilabrus tinca*, *C. quinquemaculata*, and *C. pavo*. The first part of the paper is occupied with an historical review of the relative researches of Agassiz and Whitman, Kupffer, Wenckebach and others.

Ten hours after fertilization the blastodisc is seen as a cap on the yolk, with its margin still more than thirty degrees from the equator. Along the whole margin cells stretch out towards the yolk and are constricted off. After separation from the margin these cells arranged themselves in concentric rows. They remain separated by interspaces, and the cells of one row correspond to the interspaces of the next. Certain irregularities must however be allowed. The cells are all oval, and lie with their long axis parallel to the blastodisc margin. Between them there are abundant fat globules thickest close to the margin of the blastoderm. Dr. List regards

* Biol. Centralbl., vii. (1887) pp. 81–8.

these constricted off periblast elements as cells, and not nuclei. Sections made at a later date confirmed his observations on the living objects.

Only three layers of cells at most were seen round the blastodisc margin. On sections, thirty-two hours after fertilization, there was seen below the blastodisc a single layer of cells, distinctly flattened and stretching like a flat epithelium from one margin to the other. The component cells had distinct nuclei, many somewhat larger and more spherical than those of the blastoderm. From the section Dr. List inferred that the constriction of periblast cells took place not only outwards, but also inwards below the blastoderm to form the layer just noted. How long the external budding off goes on was not determined. Without regarding the available data as adequate, the author is inclined to believe that the hypoblast arises from the periblast.

Formation of Double Monsters.*—M. C. Dareste has a note on recent researches on the mode of formation of double monsters. He allows that there are double monsters as to which his explanation by the formation of two embryonic bodies from a single cicatricula will not apply; these, which have been inexactly called monsters by lateral union, are only partially double; they are very rare among birds, but are pretty frequent among fishes after artificial fecundation. Here even there is initial duality, but the fusion takes place very early, even, he thinks, before segmentation. And he suggests that an explanation is to be found in the history of the process of fecundation; if the single fertilizing spermatozoon forms the male nucleus, would not two spermatozoa give rise to two male nuclei, or, in other words, to two foci of embryonic formation?

β. Histology.†

Chemistry of Cell-nucleus.‡—Herr A. Kossel finds that when yolk nuclein is broken up by boiling dilute acids it does not form guanin and hypoxanthin as does nuclear nuclein. Adenin is a new base formed in the decomposition of the nuclei of the pancreatic gland, and appears as an intermediate product in the formation of hypoxanthin, into which it passes under the action of nitric acid; it has been found in numerous animal and vegetable cells.

Death of Muscles.§—After death, when the muscles have ceased to respond to electrical or mechanical stimulus, there still remains a certain irritability. It is still possible to provoke contractions of final agony, which end finally in a particular form of rigidity. M. C. Rouget has studied these last manifestations of life in muscle. A small detached portion was placed on an object-glass in a drop of 6 per cent. salt solution, and the fibres teased apart. The stretched fibres contract like caoutchouc when the tension is relaxed; they twist variously when freed, with greatest rapidity in birds, mammals, and fishes among Vertebrates, and in Orthoptera and Crustacea among Invertebrates. The most leisurely movements were observed in *Hydrophilus*.

At the free extremity of the fibres a local contraction takes place, and similarly at all points where the fibres have been pressed or lacerated. In Arthropods these gradually encroach on the rest of the fibre. In frogs and lizards, after the appearance of the pads of contractions, ruptures occur,

* Comptes Rendus, civ. (1887) pp. 715-7.
† This section is limited to papers relating to Cells and Fibres.
‡ Zeitschr. f. Physiol. Chemie, x. (1886). See Bot. Centralbl., xxix. (1887) p. 39.
§ Comptes Rendus, civ. (1887) pp. 1017-20.

and the whole fibre is divided into blocks separated by empty spaces within the sarcolemma. In the blocks the transverse striæ are very closely approximated. These ruptures are the result of violent convulsive tension between the contracted and the adjacent passive portions. The first pads of contraction are the consequences of a mechanical excitation of the isolated fibre; the spreading of the contraction is due to the gradual imbibition of a foreign irritant fluid in the interstices separating the fibrils. The appearances thus artificially produced are strikingly like those seen in the dead muscle of typhoid, variola, and cholera patients. In fishes, chelonians, birds, and mammals, the direct imbibition is so rapid that the preliminary contracted pads seem to be absent. Annular swellings appear separated by constrictions, and forming an irregular transverse striation. Even in muscles apparently quite rigid, after some days, in frogs and lizards, living and contractile fibres may be found among the dead. At the commencement of rigidity the same mixture may be observed in mammals. Elasticity and contractility are lost at the same moment.

B. INVERTEBRATA.

Singular Parasite on Firola.*—Dr. J. Barrois describes a unique parasite found on the surface of *Pterotrachea coronata* in the Gulf of Villefranche. The body of the animal was red and opaque, the form triangular, the structure unique.

(1) The alimentary system consists of three distinct sacs, opening separately to the exterior at the ends of the arms. They were capable of suction by means of three muscle bundles inserted on three hyaline cords adhering to the wall of the sacs. Each sac exhibited a thick epithelial lining surrounded by a strong muscular envelope. (2) A water-vascular system was present, communicating with the interior and with the cavity of the sacs viâ the terminal claw. A partitioned central organ gives off three canals radiating to the ends of the arms. (3) The integument consisted of an external cuticle, an epithelium, rounded mesenchymatous cells, and an internal more delicate cuticle. (4) The claw at the end of each arm exhibited three chambers, communicating on the one hand with the endodermic sacs and the water-vascular system, and on the other with the exterior by means of a single terminal aperture. (5) There is a nervous system consisting of a thick trunk connecting the sensory plates formed by a thickening of integument at the root of each arm in the concave portion of the disc. Two fibrous cords extend from the dorsal face to the mass of areolar tissue above the partitioned central organ. They are bounded to right and left by an albuminous nucleated mass. The skeleton was unfortunately lost in preparation.

The only suggestion that Dr. Barrois can offer is that this unique form is possibly an Echinoderm modified by parasitism, or that it ought to be referred to a new but allied division.

Pelagic Micro-organisms of Fresh-water Lakes.†—Of late years several authors have described the numerous kinds of vegetable and animal organisms living in the pelagic region of lakes. M. H. Forel corroborates Asper's statement ‡ as to the predominance of certain forms on different days, in the Lake of Geneva. "The rich development of micro-organisms leads to a better understanding of the cycle of life in the pelagic region of the lake."

* Journ. de l'Anat. et de la Physiol., xxiii. (1887) pp. 1–17 (2 pls.).
† Arch. Sci. Phys. et Nat., xvii. (1887) pp. 60–2.
‡ See this Journal, 1887, p. 53.

The water contains in solution 0·01 gr. of organic matter per litre. This material is fixed by vegetable organisms, e.g. bacteria, algæ, desmids, diatoms, oscillaria, &c. The "aquatic dust" in suspension in the water is absorbed by Protozoa. It is the first stage in the organization of nutritive material. Larger animals, such as rotifers and Entomostraca, feed on these plants and animals. Insectivorous fishes feed on these, and carnivorous fishes prey on the last: whilst finally these are eaten by birds and man. The carcases and ejecta of all these forms serve to keep the quantity of organic material constant.

Microscopic Fauna of High Alpine Lakes.*—Dr. O. E. Imhof has investigated the fauna of various Alpine lakes at altitudes of from 600–2780 metres above the sea; after a reference to what has been done by previous observers he gives the results of his own studies. The great majority of lakes over 2000 metres harbour a pelagic fauna which is very rich in individuals; in some a *Daphnia* was particularly plentiful, and in others *Diaptomus alpinus;* up to 1796 metres (the Silsersee) there were 7–16 species in one lake; the higher the elevation the smaller the number of species; *Daphnia*, *Cyclops*, and *Diaptomus* were the most widely distributed genera; *Bosmina* was found at 1908 m. (Cavloccio); *Leptodora hyalina* was nearly always present up to 1075 m. *Anuræa longispina* was the most generally distributed rotifer, and was found as high as 2640 m. Among the Protozoa *Ceratium hirudinella* was widely and generally found as far as 1993 m. *Peridinium* extends to 2222 m. The Copepod *Heterocope robusta* was found in three lakes in the Upper Engadine.

Mollusca.

Growth of the Molluscan Shell.†—According to Réaumur (1709) the growth of the Molluscan shell was due to the mechanical deposition of a secretion. In spite of the objections urged by Méry (1710) and Hérissant (1766), who advocated an internal organic growth by intussusception, Réaumur's theory has been virtually accepted till within the last few years. A vigorous opposition by Nathusius-Königsborn in 1878, followed up by Tullberg in 1882, and Ehrenbaum in 1884, has done much to elucidate the process. According to Tullberg one portion of the shell grows by apposition, another by the modification of the outer zone of epithelial cells, while Nathusius-Königsborn maintained that the growth of the shell, though strictly internal, was independent of any cellular element. F. Müller (1885), on the other hand, was led to conclude that the shell does *not* grow independently of the cells, while his results were equally conclusive against the possibility of growth by apposition of elements secreted from the mantle. A brief summary of some of the more detailed results of the last two observers is given at the reference noted below.

Nervous System in Tenioglossate Prosobranchs.‡—M. E. L. Bouvier describes certain modifications of the typical strepsineurous arrangement in Prosobranchs, which lead on to a zygoneurous condition. Some of the Melaniidæ and Cerithiidæ have a commissure passing directly from the subintestinal ganglion of the visceral loop to the pallial (pleural) ganglion, on the right side. Other members of the group have this connection less perfect. The union between the supra-intestinal and pleural ganglion of the left side is much rarer, but M. Bouvier finds it in *Ampullaria*, *Natica*,

* Zool. Anzeig., x. (1887) pp. 13–17, 33–42.
† Naturforscher, xx. (1887) pp. 137–8.
‡ Comptes Rendus, civ. (1886) pp. 447–8. See also this Journal, 1886, p. 584.

Cypræa and others. A resemblance also holds between the Aspidobranchs (*Haliotis*) and the other prosobranchs in the arrangement of the stomatogastric nerve.

In regard to the pedal nerves, too, transverse commissures, like those of *Haliotis*, are found in *Paludina*, though few in number; but in *Cyclophorus* there may be as many as 15 in number: where also a zygoneurous condition is present. Hence this genus is more nearly allied to *Paludina* than to *Cyclostoma*.

Anatomy of Patella vulgata.*—Mr. R. J. Harvey Gibson has published the first, or anatomical, part of a projected monograph on the common limpet, in which he gives detailed accounts of the various organs, incorporating the results of the investigations of his predecessors (which he has, when possible, examined for himself), with those to which his own studies have led him.

After describing the external form, the little known and complicated alimentary canal is dealt with; on the palate and on the floor of the pharyngeal chamber there are two plates which protect the subjacent tissues from injury from the teeth of the radula; the intestine lies in apparently endless coils, the dissection of which is attended with great difficulty, not only because of the extreme tenderness of the intestinal walls, but on account also of the intricate way in which the coils are intertwined, and the intimate connection that there is between them and the liver, right kidney, and connective tissue supporting these organs; in only one out of twenty limpets was the dissection complete, and the alimentary canal was then found to measure more than fourteen inches in length, the whole antero-posterior diameter of the animal itself being only $2\frac{1}{4}$ inches.

The circulatory system consists of a branchial vein with veinlets, a heart and two efferent vessels; the branchial vein cannot be distinguished from a large lacuna, having no special lining of epithelium and its walls being composed of connective tissue. The heart consists of a large, very thin-walled auricle, and a ventricle which is practically a sponge of muscle-fibres. The functional gills are, morphologically, processes of the mantle, which, also, has a respiratory function; the mass of the latter consists of connective tissue and muscle, with large and small lacunar spaces, and the structure of the gills is essentially similar. The author agrees to Lankester's statement that the renal sac is practically a series of blood-vessels covered by renal epithelium; this epithelium is arranged in several layers; the lower cells are rounded or polygonal, and present a homogeneous protoplasm crowded with granules of a light green or brownish tinge; the upper cells are much larger, and contain a number of vacuoles, and are, further, ciliated; the right is much larger than the left nephridium, and there is possibly some difference in the chemical characters of their secretions.

The integument consists of two or three layers, according to position, a layer of light pigment-cells being added to the layer of dark pigment-cells and the layer of connective tissue in the region of the nephridia.

Nothing in the way of glands, suckers, or spicules could be made out in the foot. The nervous system is exceedingly complicated, there being no less than eight pairs of ganglia; of these the cerebral, visceral, and pedal are alone of primary importance; some of Brandt's statements as to the origin of the visceral and recurrent nerves are corrected; the account given of the eyes agrees in nearly all particulars with that of Fraisse regarding *Patella cærulea*. The two tentacles are the special organs of touch.

* Trans. Roy. Soc. Edinburgh, xxxii. (n.d.), pp. 601–38 (5 pls.).

The sexes are separate, the gonads single, and their ripe products are poured into the cavity of the right kidney, whence they escape by the right renal papilla; the generative duct described by Cuvier has, then, no existence; Dall is incorrect in denying the presence in *P. vulgata* of the "capitipedal orifices," while Spengel was wrong in regarding them as orifices, for they are the vestigia of the lost true gills. Mr. Harvey Gibson's experience does not tally with that of MM. Robin and Lebert, who failed to find the gonads in more than half the specimens they examined, for in more than one hundred specimens collected at various dates he always found the gonads, though they were sometimes small.

Concretionary Gland of Cyclostoma elegans.*—M. P. Garnault refers to the "glande à concrétions," which is found below the organs of Bojanus in *Cyclostoma elegans*. Barfurth found that the concretions were of uric acid, and, as such were wanting from the organ of Bojanus, he concluded that the gland in question was the functional kidney.

M. Garnault finds that the gland consists of numerous tubes collected into tufts, and connected to the digestive tract by loose connective tissue, while they are surrounded by a very rich vascular plexus, which can be easily injected. In the adult, at any rate, the gland is without any excretory canal. The concretions, when carefully observed, are found to be absorbed. A prodigious quantity of bacilli are to be found filling up completely the cavities of the tubes, and their presence is undoubtedly normal. The author thinks that these bacilli contribute to the deposition and the absorption of the uric acid, but he has not yet made the experiments proper for determining this question; notwithstanding the absence of uric acid from the organs of Bojanus he believes that it is nevertheless the true kidney, and suggests that the waste nitrogenous products may be excreted under some other chemical form.

Osphradium of Crepidula.†—Dr. H. L. Osborn describes the osphradium of *Crepidula* which appears to have hitherto escaped notice. In *C. fornicata* it is represented by eighteen or twenty papillæ placed in a longitudinal row on a low ridge parallel with the gill; each papilla has a globular expanded head supported on a short narrow peduncle. The longitudinal axis of the organ is traversed by a nerve-trunk which sends a branch into each papilla; the free ends of the columnar epithelial cells appear to be ciliated, and those doubtless are sensory in function which are placed at the summit of the papilla, where there is no distinct basement membrane, as there is on the sides.

A hitherto unnoticed area of peculiarly modified epithelium runs along the ridge from which the gill-filaments arise; this consists of very tall cells, altogether unlike any other that are found on the mantle, and they are so set as to form what appears to be a specialized organ.

Terrestrial Air-breathing Molluscs of the United States.‡—Mr. W. G. Binney has published a second supplement to the fifth volume of his 'Terrestrial Air-breathing Molluscs of the United States and adjacent territories.' It contains lists of the locally introduced species, the universally distributed species, and the Central and Pacific province species. The most variable species found in North America appears to be *Patula strigosa*, the geographical range of which is very great; the various forms are considered under the three heads of (α) shell transversely ribbed, (β) shell smooth or with rough striæ, (γ) shell longitudinally ribbed;

* Comptes Rendus, civ. (1887) pp. 708–9.
† Zool. Anzeig., x. (1887) pp. 118–9.
‡ Bull. Mus. Comp. Zool., xiii. (1886) pp. 23–48 (3 pls.).

thirteen varieties are considered, and some of their characters noted. *Triodopsis Sanburni*, *T. Harfordiana*, and *T. Hemphilli*, are new species. In dealing with the species of the Pacific province, those from the extreme northern region are not included, as they more properly belong to the fauna of Asia.

Molluscoida.

a. Tunicata.

Colonial Vascular System of Tunicata.*—M. F. Lahille denies that the colonial Tunicata generally have a common vascular system, and asserted that this only is rarely present. The genera that have a colonial plexus are those in which there is a basal stolonial blastogenesis, such as *Perophora*, *Clavulina*, some of the Cionidæ, and some of their allies. What, in other Tunicates, has been taken for such a plexus, has really a very different significance; in the Diplosomidæ, Didemnidæ, and Leptoclinidæ, there are muscular cones, which have a fixing function, and as they may be very long and underlie the substance of the tunic, they have been mistaken by M. Giard for vessels. In the Aplididæ there is not even an appearance of a colonial plexus; in the Botryllidæ the anastomoses of the vascular appendages only appear after blastogenesis. As most of the Synascidians are merely aggregations, they are only separated from the Monascidians by their blastogenetic origin, and as the entirely blastogenetic origin of the cormus and the general presence of a colonial vascular plexus has been shown not to obtain, M. Lahille thinks that there is no longer any reason for separating these two orders of Tunicates.

New Organ of Respiration in Tunicata.†—Prof. W. A. Herdman gives an account of the structure and distribution of blood-cavities in the test of various Tunicates; the disposition and anatomical characters in the different regions and layers of the test lead him to think that in most Ascidians these tubes exercise more or less perfectly a respiratory function; further evidence is afforded by the relation which exists in many groups between this system and the branchial sac or chief organ of respiration. When the sac is large and highly developed, the vessels in the test are few and small, but when the branchial sac is small, simple, and apparently inefficient, the vessels in the test are numerous, of large size, and disposed in such a manner as to suggest at once that they are concerned in the aeration of the blood.

'Challenger' Tunicata.‡—Prof. W. A. Herdman reports on the compound Ascidians collected by the 'Challenger.' This, one of the most difficult of all groups of animals, was represented by 25 genera and 102 species; ten of the former and 88 of the latter are regarded as new. The forms are chiefly littoral in habitat, only seven extending to a depth of 1000 fathoms; one of the most remarkable is *Phenyngodictyon mirabile*, which was taken from a depth of 1600 fathoms. The compound Ascidians are regarded by the author as having had a polyphyletic origin among the simple forms.

β. Polyzoa.

Critical Notes on Polyzoa.§—The Rev. T. Hincks commences by discussing the characters of the family Adeoneæ, with especial reference to the "somewhat heterogeneous company" included in it by the late Mr.

* Comptes Rendus, civ. (1887) pp. 239–42.
† Proc. Lit. and Philos. Soc. Liverpool, xxxix. (1885) pp. 39–46 (1 pl.).
‡ Reports of the Voyage of H.M.S. 'Challenger,' xxxviii. (1886) pp. 432 (49 pls.).
§ Ann. and Mag. Nat. Hist., xix. (1887) pp. 150–64.

Busk. He says that the pores in one section of the group have a totally distinct morphological significance, and have possibly also a different function from that of the other. He proposes to refer to the Microporellidæ that division of the Adeonidæ which exhibits the zoœcial structure characteristic of the genus *Adeona*, and this is the view of Prof. Smitt. With regard to the question of dividing the genus *Adeona*, it is remarked that there is no element of structure among the Polyzoa so liable to adaptive modifications as the so-called radical appendages, and Mr. Hincks thinks that the species may well be ranged under the two heads of (1) with a flexible stem and (commonly) fenestrate zoarium, and (2) without a flexible stem.

Treating of the Membraniporidæ the author discusses his species *Membranipora radicifera*, and has some notes on the genera. The family characters of the Microporidæ are defined, as are also those of the Steganoporellidæ; this last contains at present three genera, the third of which—*Thalamoporella*—is new.

'Challenger' Polyzoa.*—The late Mr. G. Busk's second report on the Polyzoa of the 'Challenger' treats of the Cyclostomata, Ctenostomata, and Pedicellinea; forty-six species are enumerated, of which thirteen appear to be new. The Pedicellinea are represented by *Ascopodaria fruticosa* and *A. discreta;* Mr. Busk gives his reasons for preferring his generic name to *Barentsia* or *Pedicellinopsis.*

Key to the Fresh-water Polyzoa.†—A useful analytical key to the known species of fresh-water Polyzoa, with figures, is published in the journal noted at foot. It is based on Dr. J. Jullien's 'Monographie des Bryozoaires d'eau douce.'

Fresh-water Bryozoa.‡—Dr. W. Reinhard repels the accusation of Herr Ostroumoff that in his account of the metamorphosis of *Alcyonella fungosa* he only describes pathological processes. He confirmed the observations of Nitsche, and as to what he has added to them with regard to a special appendage there is no question of pathological change. Herr A. Ostroumoff has a reply to these criticisms.§

Arthropoda.

Classification of the Arthropoda.‖—Prof. E. Ray Lankester publishes a further answer to Prof. Claus, in which he repeats his statement that what Prof. Claus announced as novelties had been formulated by him five years previously, and he discusses the explanations given by Prof. Claus.

Digestive Tract of Arthropoda, and particularly of Insects.¶—Prof. A. Schneider has discovered that the tunica propria which underlies the endodermal cells of the midgut of Arthropods, consists of chitin. Where the foregut of insects is united with the midgut there is a remarkable, and as yet unnoticed, arrangement of the longitudinal fibres; they arise behind the middle of the foregut and become separated from the intestine, a part only being inserted behind the commencement of the midgut; this must cause an invagination of the foregut, and so lead to the formation of a proboscis which leads to various structures; it may be simple or lobed, or beset with setæ and teeth, and so on. The proboscis is of some size in the larvæ and

* Reports of the Voyage of H.M.S. 'Challenger,' l. (1886) 47 pp. and 10 pls.
† Journ. Trenton (N.J.) Nat. Hist. Soc., 1887, pp. 59–67 (1 pl.).
‡ Zool. Anzeig., x. (1887) pp. 19–20.
§ Tom. cit., pp. 168–9.
‖ Ann. and Mag. Nat. Hist., xix. (1887) pp. 225–7.
¶ Zool. Anzeig., x. (1887) pp. 139–40.

imagines of Diptera, Orthoptera, Forficulidæ and *Lepisma;* it is smaller in the Coleoptera and Neuroptera, and is wanting in other insects. At the hinder end of the foregut of many insects the cuticle forms a fold which extends as far as the anus in the form of a tube. Professor Schneider proposes to call it the infundibulum. It is generally present in all the forms that have a proboscis, but is wanting in the Dytiscidæ and Carabidæ among the Coleoptera, and is found in all larvæ except those of Lepidoptera. All the insects and larvæ that possess it eat hard and even indigestible foods, while the others take fluid nutriment. When it is present in the larva it may persist in the imago even when, as in the Diptera, the mouth-organs and the mode of life are altered. Where it is found, the materials taken into the intestine do not touch the surface of the mid- or hindgut. The enteric respiration which obtains in many insects has no effect on the contents of the intestine, as the infundibulum is elastic and firmly incloses the contents. This structure was first seen by Wagner in the viviparous larvæ of the *Cecidomyiæ*, where alone it has till now been noticed.

Comparative Morphology of the Brain in Insects and Crustacea.*—M. H. Viallanes gives the names *protocerebrum*, *deuto-*, and *trito-cerebrum* to the three lobes of the supra-œsophageal ganglion of the decapod Crustacea. He compares each lobe, which consists of two lateral halves connected across the middle line, to a ganglion of the ventral chain; although the trito-cerebrum appears not to be so connected. But from an examination of these parts in some of the Orthoptera, he finds a commissure between these lobes passing below the œsophagus. The protocerebrum innervates the eyes in both Crustacea and Insects; the deutocerebrum innervates the antennæ of insects, and the antennules of Crustacea, and the nerve rises in two roots; in both classes a nerve passes from this lobe to the integument; the tritocerebrum sends nerves to the second antennæ in Crustacea, and to the labrum in Insects: hence he draws an homology between these structures; and concludes that there are three prebuccal segments in both classes.

a. Insecta.

Vision of Insects.†—M. A. Forel gives an account of past and recent experiments on the vision of insects, and sums up the conclusions as follows:—

(1) Insects direct themselves, in flight almost wholly, and on the ground partially by means of their facetted eyes. The antennæ and buccal sensory organs cannot serve for directing flight. Their extirpation makes no difference.

(2) J. Müller's mosaic theory is alone true. The retinulæ of the compound eyes do not each receive an image, but each receives a simple ray more or less distinct in origin from that of its neighbours. Gottsche's theory is false. (Müller, Grenacher, Exner.)

(3) The greater the number of facets, the more elongated the crystalline cones, the more distinct and the longer the vision. (Müller and Exner.)

(4) Insects can see particularly well the movements of bodies, and better during flight than when at rest, the image being displaced in relation to the eye (Exner). This perception of the mobility of objects diminishes as the distance increases.

(5) Contour and form are only indistinctly appreciated, and the more indistinctly the fewer the facets, the shorter the crystallines, the farther

* Comptes Rendus, civ. (1887) pp. 444–7.
† Rec. Zool. Suisse, iv. (1886) pp. 1–50 (1 pl.).

and smaller the object. Insects with big eyes with several thousand facets can see with tolerable distinctness.

(6) In flight, insects can by means of their compound eyes appreciate with accuracy the direction and distance (not too great) of objects. When at rest they can also estimate the distance of fixed objects.

(7) Certain insects (bees and humble-bees) can clearly distinguish colours, and that better than form. In others (wasps) the perception of colour is very rudimentary. Ants perceive the ultra-violet rays (Lubbock).

(8) The ocelli seem to furnish only very incomplete vision, and to be simply accessory in the insects which possess also compound eyes.

Function of Antennæ.*—Prof. V. Graber communicates the results of further experiments on the function of antennæ. These corroborate his previous conclusions, that strong smells affect the delicate portions of the skin, and that finer smells useful in nutrition are in some cases certainly and specially appreciated by the antennæ. The author answers some apparent misunderstandings of Plateau, and proceeds to subject the experiments of his colleague to a searching criticism, showing that Plateau's *proof* of the olfactory function of the antennæ in the cockroach is false and inadequate, though the conclusion is indeed correct. Graber chronicles his own experiments, showing that cockroaches without feelers can hardly or in no wise smell, and that the feelers really and specially act as smelling organs. He does not, however, affirm this as a general proposition, since some insects appear to have no sense of smell whatever, while others can smell their food even when robbed of their antennæ. Further details are promised in a work in preparation.

Holopneusty in Beetles.†—Dr. E. Haase communicates a note on the import of the distribution of stigmata in larval beetles. Fr. Brauer (1869) expressed the opinion that lank active larvæ were the primary forms, and the sluggish grubs secondary adaptations. Lubbock confirmed this, and Palmén supported the distinction by reference to the morphology of the tracheal system. In addition to three previously reported (Elmis and two Lycidæ), Haase notes four cases of holopneustic larval forms (Telephorus, Phengodes, Lampyris, and various Drilidæ). Insects without quiescent pupa stages, with so-called incomplete metamorphosis, may be ranked along with the above beetles as forms with persistent distribution of stigmata, as "menotreme,"—in contrast to "metatreme" insects in which the holopneusty of the imagines has been re-acquired in post-embryonic development. According to the primary or secondary development of the mouth-parts, Fr. Brauer similarly divided insects into "Meno-" and "Metagnatha." With the exception of *Elmis* the holopneustic larval forms mentioned belong to the Malacodermata division of beetles which in many ways approach near to the primitive Coleopteran form. The individual development is thus also primitive; the larvæ are comparatively like the imagines, being modified only by a few secondary influences. Their metamorphosis is thus in a certain way related to the anamorphosis of the Hemimetabola (*Homomorpha*). "The quiescent pupa-stage which, though ever so imperfectly, they pass through, is to be referred to and explained as (in Brauer's words) 'abbreviated stages of growth,' as the secondary, almost synchronous compression of several genealogically successive and distinctly separate steps of developmental progress."

Labium of the Coleopterous genus Stenus.‡—Herr F. Meinert explains the peculiarities in the structure of the mouth-organs of *Stenus* as

* Biol. Centralbl., vii. (1887) pp. 13–9.
† Ibid., pp. 53–4.
‡ Zool. Anzeig. (1887) pp. 136–9.

being due to the fact that the primary or sternal piece of the labium and the connective membrane which unites it with the mentum are extraordinarily elongated; in consequence of this the primary piece can be protruded and withdrawn through a considerable space; the paraglossæ are wanting. The labial palps are remarkable for their club-shaped form, but this is not quite so remarkable, as an examination of the genus *Megalops* would show. Figures in illustration are promised in a more extensive memoir which will shortly appear.

Prothoracic Appendages of Lepidoptera.*—M. N. Cholodkovsky, referring to the previous communication made by Dr. Haase, allows that the presence of prothoracic appendages has been noted by previous writers, but he traverses the opinion of his critic that the parts in question are secondary accessory structures. The justice of this criticism, and of others like it, is difficult to determine, but the following facts seem to speak against Dr. Haase; structures which are morphologically of the same value appear in different forms at very different stages in development, and the late appearance of the appendage is not *pro tanto* an argument against their primary nature; again in the development of the Squillidæ we find pairs of extremities well developed in the Protozoea-stage, which atrophy in the zoea, and again appear after metamorphosis. In position the prothoracic appendages agree better with rudiments of wings than with tegulæ, and in structure they are not hard solid chitinous plates, as are the tegulæ, but soft vesicles filled with blood and tracheal branches.

Morphology of Malpighian Tubes in Lepidoptera.†—M. N. Cholodkovsky has studied the morphology of the urinary system of Lepidoptera which turns out to be less uniform than is usually supposed.

(*a*) In *Tineola biselliella*, for instance, there are only two long simple tubes, while in the Lepidoptera generally there are always six. In the caterpillars of *Tineola*, however, there are six as in other Lepidopteran caterpillars. On the second day of chrysalid life the six tubes exhibit symptoms of degeneration. The terminal tubes gradually disappear by histolysis, the basilar trunk increases, and eventually gives rise to the simple urinary apparatus of the adult. The author notes the probable connection of this series of changes with the abundant nutrition of the caterpillar, the fasting life of the pupa, and the advantage of lightness in the adult insect.

(*b*) In *Galleria melonella* the urinary system is represented by two richly and irregularly ramified trees; neither basilar trunk nor terminal tubes nor bifurcation of a trunk into branches. A very short lateral prolongation of the intestine is regarded as homologous with the basilar trunk. In the caterpillar the usual six vessels are present, and these disappear as above, being replaced by a secondary arborescent growth in the chrysalis. The caterpillar devours enormous quantities of fatty substance. It is probable that this reserve store is utilized in the chrysalis phase, and the great development of the urinary vessels would permit of the rapid elimination of large quantities of oxidized material.

(*c*) In the other Lepidoptera the variations are insignificant: a brief summary of their peculiarities in the different families is communicated.

(*d*) The embryological studies of Hatschek and Tichomirow have shown that the Lepidopteran embryo has only two basilar trunks arising as diverticula from the rectum. In *Tineola biselliella* these are much

* Zool. Anzeig., x. (1887) pp. 102-3.
† Arch. de Biol., vi. (1887) pp. 497–514 (1 pl.).

elongated; in *Galleria melonella* they are associated with an arborescent growth. In most Lepidoptera three terminal tubes are formed on each side. Two first appear and one bifurcates. The author notes the fundamental importance of the basilar trunk, the structure of the system in the more primitive Tracheata, discusses the theory of atavism, and finally distinguishes, as above, the three types of urinary system in Lepidoptera: (1) *normal*, with six vessels joining the intestine by two basilar trunks (majority); (2) *atavistic* or *embryonic*, with two simple vessels (*Tineola biselliella*, *Tinea pellionella*, *Blabophanes rusticella*); and (3) abnormal (*Galleria melonella*) with two ramified trees.

Cause and Extent of Colour-relation between Lepidopterous Pupæ and surrounding surfaces.*—Mr. E. B. Poulton has made a series of experiments with lepidopterous pupæ for the purpose of testing the correctness of his idea that the relation between the colour of lepidopterous pupæ and their surroundings was a physiological one, and that the reflected light would be found to act on the larva at some time before pupation, and not on the pupa itself; it also seemed to him to be probable that the sensitive area might be defined by experiment.

Experiments made on *Vanessa Io*, in which six mature larvæ were placed in a glass cylinder surrounded by yellowish-green tissue-paper, resulted in five changing into the rarer yellowish-green form of pupa. Over 700 specimens of *V. urticæ* were experimented on; and observations were made on the result of different colours, the effects of mutual proximity, the effects of illumination, and the times during which the larvæ are sensitive; experiments on various parts of the body showed that the whole skin area is susceptible. Further observations were made on *V. Atalanta*, *Papilio Machaon*, *Pieris brassicæ* and *P. rapæ*, *Ephyra pendularia*, and *Saturnia carpini*; the study of the last seems to show that the influence of the surroundings can only be explained by the supposition of a complicated physiological and apparently nervous circuit.

Lepidopterous Larvæ, Pupæ, &c.†—Mr. E. B. Poulton after detailing his observations on the larvæ of *Smerinthus tiliæ* and *S. ocellatus* and the red spots in their larvæ, as also on the markings of the adult larva of *Acherontia atropos*, describes the markings aiding in the terrifying aspects produced by the attitude of the larva of *Chærocampa Elpenor*. The terrifying attitude of the larva of *Dicranura vinula* produces an exaggerated caricature of a sort of generalized vertebrate appearance, e. g. a serpent, such as would alarm small birds, and in this larva a fluid consisting of formic acid is ejected from a gland, the duct of which opens below the head, and so arranged that when the larva is disturbed, the fluid is directed directly forwards. In *D. furcula* there is a green eversible gland occupying the same position as this poison-gland, and the author considers this to be a more primitive arrangement. The larva of *Orgyia pudibunda* has an eversible gland situated in the median dorsal line of the seventh abdominal segment, and eversion takes place when the larva rolls up. The larva of *Hemithea thymiaria*, in its normal attitude, has a very perfect resemblance to a twig, owing to its head being notched, and to the presence of dorsal tubercles. The early life of the larva of *Acryonycta leporina* is passed on the lower side of the leaf of the alder or beech. It is concealed by its long white hairs, but later on, when about to burrow in the bark, the hairs become darker and thus render it less conspicuous.

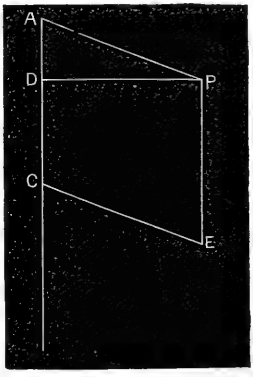
The apparatus by means of which imagines escape from the cocoon is

* Proc. Roy. Soc., xlii. (1887) pp. 94–108.

† Trans. Entomol. Soc. Lond., 1886, pp. 137–79 (1 fig.).

noted. The cocoons of the Chloephoridæ have a sharp ridge at the anterior extremity; this ridge is formed by two closely fitting edges, forming a valve, this can be easily opened from within, to allow the imago to escape, but will not yield to any ordinary pressure from without. The larva of *Paniscus cephalotus*, parasitic on the larvæ of *Dicranura vinula*, is also described, as well as its development. The author deals with the distribution of derived plant pigments. These are found to be differently distributed in various larvæ. In some *Noctuæ* green pigments are dissolved in the blood; in the green Sphingidæ, the pigment passes from the blood into the cells of the hypodermis. Before pupation the pigments are withdrawn and dissolved in the pupal blood. Various tables are given bearing on the loss of weight in the pupa immediately after throwing off the larval skin. This loss of weight is chiefly due to evaporation from the surface of the body, but also to the active muscular effort of pupation, entailing loss of water, and carbonic acid through the tracheal system. On the other hand, there must be a gain of weight due to absorption of the oxygen, which is stored up as the oxidized products of nitrogenous metabolism, which fill the digestive tract of the pupa and imago within it.

Fig. 95.



Geometrical Construction of the Cell of the Honey-bee.*—Prof. H. Hennessey gives a figure and the method by means of which the lozenges composing the cell can be obtained.

On a straight line take a part A D, and lay off D C = 2 A D. From D erect a perpendicular, and with a radius A C = 3 A D cut off DP: then A C and A P are sides of the lozenge A C E P. From this, the remaining two lozenges, and also the six trapeziums can be obtained. The triangular pyramid which terminates the bee's cell may be inscribed in a sphere whose diameter is three times the size of one of the edges of the pyramid. The diameter of this sphere can be found by a mathematical formula which he gives.

Anatomy and Histology of Culex nemorosus.†—Herr W. Raschke states that in general habit the larva of *Culex nemorosus* resembles the aquatic larva of the Nemocera; the cylindrical body consists of twelve somites, the first three of which are fused to the thorax. The strong chitinous tubes which project from the penultimate somite are very striking; a valvular apparatus not only enables the animal to remain at the surface of the water, but also serves to close the tracheal endings in the siphon; these have also a peculiar constriction, the mechanism of which is connected with the valves and serves as a second closing-organ. Respiration is also effected by anal gill-plates, and by an exchange of gases through the integument; the rectum is provided with means for containing a large number of tracheal branches. In addition to the two pairs of eyes, the larva has various sensory hairs, which are found not only on the antennæ and epipharynx, but are also specially arranged over the whole body.

Males of Lecanium hesperidum, and Parthenogenesis.‡—M. R. Moniez has found the males of *L. hesperidum* in a large number of females examined between September and February: each male was in a separate ovarian

* Proc. Roy. Soc., xli. (1886) pp. 442–3 (1 fig.). See this Journal, 1886, p. 234.
† Zool. Anzeig., x. (1887) pp. 18–9. ‡ Comptes Rendus, civ. (1886) pp. 448–51.

cæcum: and these cæca were mixed up with those containing larvæ of females. The development of the male larva was traced to the perfect state; when it is characterized by its small size, thin integument, absence of eyes and of wings, and by the development of spermatozoa before the appearance of the appendages.

The development of the spermatozoa differs considerably from that in neighbouring forms.

Although doubtful on the point, M. Moniez considers it probable that impregnation takes place while the male is still within the female: and he shows how, by a farther reduction of the male, till it is represented by only sexual elements, a false hermaphroditism may be brought about. Thus, many cases of parthenogenesis and pædogenesis may really be gamogenetic, since the pseudova may be ordinary ova, fertilized before being laid, by means of the spermatozoa, which are all that represents the male.

Galls on the Leaf of the Vine.*—Herr T. von Ohrdruf states that on the leaves of vines, cultivated in Europe, three kinds of galls can be distinguished:—(1) The Erineum of *Phytontus Vitis*, (2) the Phylloxera gall, and (3) the gall of *Cecidomyia œnophila*.

The Erineum cannot be confounded with the other two; but in order to distinguish the two latter, the following characters are given. The galls of *Cecidomyia* project from both surfaces of the leaf, are circular in form, and their colour varies from greenish yellow to deep red. They are spread over the leaf without any order, and their number is sometimes as many as from thirty to sixty. The Phylloxera galls are of the same shape, the difference, however, is that these galls on the upper surface of the leaf have a roundish or fissure-like opening, bordered by hairs and projections, while on the under surface of the leaf there is a large projection with a contraction at its base. The gall of *Cecidomyia* has no opening on the upper surface, is small, and lenticular in form.

β. Myriopoda.

Ancestors of Insects.†—Dr. E. Haase thinks that *Scolopendrella* stands nearest to the primitive insect or Archentomon; it is distinguished by its multiarticulate antennæ; three pairs of jaws, of which the last is poorly developed, its twelve pairs of five-jointed ambulatory legs, and a pair of long caudal appendages in which is placed a spinning-gland. It is also remarkable for its abdominal processes; these appear to correspond morphologically to the calcaria of most Tracheata, and are homologous with the appendages on the last two pairs of legs in *Machilis;* from the second to the eleventh segment there are clefts leading to pouch-like glands, which may be distinguished as the abdominal pouches; these obtain also in most of the Thysanura, in *Peripatus*, and some Myriopoda. The evidence afforded by larvæ of insects is also discussed, and some of the difficulties explained by supposing that separate developmental phases which appeared successively are compressed and intercalated with one another in the course of ontogenetic development. The wings may be regarded as folds of the dorsal plate.

Relationships of Myriopods.‡—Starting from *Scolopendrella*, Dr. E. Haase seeks to derive from a related type the orders of Myriopods and of apterygota or lowest insects. He lays emphasis on the morphological

* Entom. Nachr., 1886, pp. 129–35. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 219.

† SB. und Abhandl. Isis in Dresden, 1886 (1887) pp. 85–91.

‡ Biol. Centralbl., vi. (1887) pp. 759–60. (Ber. Versammlg. Naturf. u. Aerzte Berlin, 1886.)

importance of the ventral appendages—"Hüftspornen" and "Hüftdrüsen." Terminal spurs are represented in *Scolopendrella* and many Chilopoda by simple immovable epithelial structures on most of the appendages, though sometimes peculiarly displaced. The well-developed appendages, corresponding to "hip-spurs," and usually designated parapodia, as in *Machilis*, serve for location, while the true extremities are reduced. "Hip-glands," demonstrated in *Peripatus*, occur also in *Scolopendrella*, *Machilis*, *Campodea*, &c., in *Craspedosoma* and *Lysiopedalium* among Diplopoda, in *Lithobius* on the last four (rarely five) segments, and finally in *Chilepimorpha*, in which the hips are reduced, on the pleural plates of the last limb-bearing segment. They secrete a gummy secretion of use in attachment to smooth surfaces, for fastening the spermatophores in *Geophilus*, &c. The Symphylid Myriopods are to be regarded as primitive. The epimorphous *Campodea* and *Japyx* are in close relationship to the hemimetabolic (anamorphous) Hexapods, and from these certain beetle families (Lampyridæ, Phengodes) afford transition forms to the holometabolic (Metamorpha) insects.

Mechanism of Respiration in Myriopoda.*—M. J. Chalande describes a series of experiments on various species of Myriopods, undertaken in order to ascertain whether respiration in these animals resembled, in its mechanism, that in insects.

By means of a simple apparatus, which is described, he was able to examine the animals, while alive, under the Microscope, in order to determine whether there were any external movements of inspiration and expiration, movements of contraction either transverse or longitudinal, or of the rings upon one another. The result is negative. Another series of experiments, in which the animals were partially asphyxiated, either by water or carbonic acid, and were then restored by a current of air, was made in order to ascertain whether the stigmata could be completely closed. The answer to this was also a negative. The experiments are described in detail, and the following genera were experimented upon, in some cases two or more species of the genus were used:—*Geophilus*, *Schendyla*, *Himantarium*, *Scolopendra*, *Cryptops*, *Lithobius*, amongst the Chilopoda; and *Glomeris*, *Iulus*, *Blaniulus*, *Strongylosoma*, *Polydesmus*, amongst the Chilognatha.

The results of his experiments are given in a résumé at the end of the paper, as follows:—

"The mechanism of respiration in Myriopoda differs entirely from that in Hexapoda.

1. During repose, there are no movements of dilatation, or of contraction of the body-cavity, capable of producing or aiding inspiration and expiration.

2. Neither the stigmata nor the substigmatic membrane, execute movements in direct relation to respiration.

3. The external aperture of the stigma does not contract.

4. The stigmata play only a passive part, serving only as a means of communication between the external air and the respiratory apparatus.

5. The substigmatic pouches, where they exist, can, in certain cases, contract, under the influence of external causes.

6. The excrescences which occur upon the substigmatic membrane, can obstruct the stigmata, under the influence of external causes.

7. This obstruction is only partial. The respiratory apparatus is never completely closed.

* Bull. Soc. d'Hist. Nat. Toulouse, 1886, and Comptes Rendus, civ. (1887) pp. 126–7. See this Journal, 1886, p. 434.

8. The internal substigmatic membrane functions as a protector of the respiratory apparatus.

9. The respiratory apparatus possesses no movements of its own capable of producing influx or expulsion of air.

10. Inspiration and expiration are caused by the rhythmical movements of the dorsal vessel, and during repose this is the only cause.

11. During activity other causes aid respiration—in walking, the action of the muscles on the tracheæ, and during digestion the movement of the alimentary tract.

12. The intensity of respiration varies according to the temperature."

Stigmata of Scolopendridæ.*—Dr. E. Haase, who has been investigating the Indo-Australian Chilopoda, finds the simplest form of stigma in *Lithobius* and *Henicops;* it is distinguished by a feebly developed peritrema, by a shortish cone invested by rather short setæ, the absence of a special closing apparatus, and by tracheæ which are cylindrical and open singly; a similar form is found in the young of *Scolopendra* and *Heterostoma*. This simple form gave rise to both the cleft-like and the sieve-like stigmata. In *Cryptops* the original form is still distinctly seen, while in *Cormocephalus* the round orifice becomes more slit-like and distinctly bounded, and the simple circlets of spines before the orifice of the tracheæ lead to the stigma of the true Scolopendridæ. In the latter the stigmatic cavity divides into an outer vestibule and the true cone, while the circlet of spines is very highly developed.

The ear-shaped or branchiform stigma of *Otostigma* and *Branchiostoma* is due to the oblique form of the cone along a small part of its length; on the base of the stigmata of these forms there appear a few of those irregular darkly coloured patches, beset with small hooks, which are so common in the Chilopoda. These patches are the vestiges of the primitive base of the stigma, the clear surrounding parts being formed by the gradual flattening and widening out of the tracheæ; the external orifice of the ear-shaped stigmata is round and finely toothed at its margin, but there is no projecting ring.

The sieve-shaped stigma, e. g. that of *Heterostoma*, may be derived from this last—by supposing the floor of the stigmatic cone to become considerably widened out, the tracheæ approximated and multiplied, and the distance between the edge of the stigma and the floor of the cone gradually diminished. Although the first pair of stigmata in *Heterostoma* may be as much as 4 mm. in size, and even project beyond the plane of the body, the last shows a depression of the cone, such as is typical of *Branchiostoma*. The author has not been able to find a connecting link between the cleft-like and the ear-like stigmata. As an embryonic character of the young Scolopendridæ we have the peculiarity that each stigma is protected by a strong hook-shaped chitinous process, as much as 0·2 mm. broad; this may be regarded as a fold of the pleura. It is a secondary arrangement, adapted to the special conditions of their early life.

δ. Arachnida.

Development of Spiders.†—Herr W. Schimkewitsch has attempted to clear up some of the obscurity that has surrounded the development of spiders. He gives an historical review of the comparatively small number of important researches. No investigator has hitherto succeeded in detaching

* Zool. Anzeig., x. (1887) pp. 140-2.

† Arch. de Biol., vi. (1887) pp. 515-84 (6 pls.).

the embryo from the vitellus and making preparations of the isolated embryo. The author treated the ova of *Agelena* with 10 per cent. chromic acid for twenty-four hours, and effected the desirable result of isolation.

(*a*) *The egg envelopes.* The double membrane, demonstrated with acetic acid, consists, as Ludwig and Balbiani have shown, of two layers—an internal vitelline membrane and a superficial chorion. In *Pholcus* the little ovarian follicles are seen to be provided with a layer of epithelial cells, probably sharing in the formation of deutoplasm. The chorion is probably, however, due to the walls of the oviducts. The two envelopes are quite homogeneous. Outside the chorion is a layer of refractive corpuscles, soluble in alcohol. These are for the most part due to the epithelial cells of a special organ, the "uterus." (*b*) As to the *constitution of the ripe ovum* the author's observations have shown him (1) that the alleged division of the plasmic material into two layers does not exist, although under the vitelline envelope a peripheral accumulation of protoplasm may be readily observed; (2) that no "yolk-nucleus" is ever seen in the ripe egg, and that Schütz's interpretation is correct; (3) that the germinal vesicle does not disappear. (*c*) In regard to *segmentation*, Schimkewitsch criticizes the relative observations, and notes his own. He observed the division into four, eight, and sixteen segments, which from the exterior looked like rosettes. The yolk-globules were disposed in columns, but remained separate from one another. In sections the somewhat excentric segmentation cavity was seen. The segments were seen as pyramids internally abutting round the cavity. At the end of segmentation, a section through the centre exhibits in *Tegenaria* and *Epeira* upwards of forty pyramids. The contained protoplasmic mass then increases and becomes polynuclear; the internal extremities are resolved into yolk-spherules which fill the segmentation cavity. The protoplasmic masses and their nuclei undergo remarkable modifications. The chromatin of the nuclei mingles with the surrounding plasma. The protoplasmic masses are transformed into blastoderm cells, which are probably separated off at the peripheral extremity of the pyramids. (*d*) At this stage the egg thus exhibits two layers—the primary ectoderm of flattened cells, and the primary endoderm represented by polynuclear vitelline cells. Sometimes almost simultaneously, but often successively and in different order, the vitelline pyramids are destroyed, the primary ectoderm or blastoderm is concentrated, and *the mesoderm is formed.* Each pyramid breaks up into rounded polynuclear cells, and the destruction may occur in various directions. The author believes in an actual migration of blastoderm cells from the dorsal to the ventral pole. But after this the dorsal side of the egg reacquires a cellular mantle by the multiplication of blastoderm cells. The formation of mesoderm is signalized by the appearance, on the ventral surface of the egg, of a whitish spot (first stage), which increases gradually (second stage) and takes the form of a tubercle (or cumulus), and before this tubercle a whitish streak. The rudiment has, as Herold said, the form of a comet. Fourthly, before the cumulus primitivus a white spot appears, at first united to the cumulus by the streak above mentioned, but in the fifth stage separated from it by a depression. In regard to the first mesoderm cells, Schimkewitsch believes that in those forms where the concentration of the blastoderm precedes the formation of the mesoderm, the destruction of the vitelline pyramids occurs equally throughout the egg, and the first mesodermic cells are separated from the internal vitelline cells. In those forms where the mesoderm is formed before the concentration of the blastoderm, the destruction of pyramids takes place more energetically on the ventral surface, and the first cells are separated from two pyramids placed

close together. He regards the depression of the ectoderm during the formation of the mesoderm as a rudimentary blastopore, and the cumulus primitivus as its posterior margin

The development of the external form is described in the second chapter of the memoir, but hardly admits of brief summary. He points out *inter alia* that Balfour has erroneously described the cheliceræ in the embryo of *Agelena* as in the form of pincers. The mandibular ganglion is not visible from the exterior, and what Balfour figures as such is the basal joint of the cheliceræ.

The *organs* derived from mesoderm and endoderm are in the third chapter discussed at length. The somatic layer gives origin to (1) all the musculature of the body except that of the mesenteron if such exist, (2) the aponeurotic layer of the cephalothorax, (3) the sub-cutaneous connective tissue and the lining membrane of all the organs arising by invagination from the ectoderm, (4) the sarcolemma and neurilemma. The splanchnic layer is the origin of the membrane of the midgut, the genital organs, the pericardium, and the pulmonary veins. At the expense of the dorsal mesenteron are developed (1) the heart, (2) the lateral arteries, and (3) the mooring apparatus of the heart. The partitions give rise to the blood corpuscles. The wall of the heart is formed by two mesodermic plates which correspond to the dorsal mesenteron of Annelids. The cardiac wall of Arthropods corresponds simply to the myocardium of Vertebrates. The cavity of the heart corresponds to the segmentation cavity. The pericardiac cavity in spiders, as in Mollusca and Vertebrata, is a part of the cœlomic cavity.

The *ectoderm* gives rise to (1) the chitinous and chitinogenous layer of the integument, (2) the epithelial layer and internal tunic of all the glands, (3) the epithelium and internal lining of tracheæ and lungs, (4) the epithelium and lining of the œsophagus, rectum, stercoral pouch, and Malpighian vessels, (5) the nervous system and eyes. The central nervous system of spiders is derived from three ectodermic rudiments—(1) two thickenings of the cephalic lobe, (2) two longitudinal thickenings of the ventral wall of the embryo, and (3) a ventral median and unpaired rudiment. Its origin is exclusively ectodermic. The latter part of the memoir is occupied with a general discussion of the homologies of the nervous system of Bilateria, illustrated by diagrammatic figures.

Reported Suicide of Scorpions.*—Prof. A. G. Bourne has made a number of experiments on three species of scorpions found at Madras, with the object of determining whether or no scorpions are able to commit suicide. He finds that it is undoubtedly physically possible for a scorpion to sting itself in a vulnerable place, and when one is placed in very unpleasant circumstances it not unfrequently lashes its tail about, and causes actual penetration of the sting. But the poison of a scorpion is quite powerless to kill the same individual or another of the same or even of another species; it is, however, very rapidly fatal to a *Thelyphonus*, less rapidly so to a spider, and much less rapidly so to an insect. Two scorpions, when fighting, repeatedly sting one another with little if any effect, the stronger killing the weaker by actually pulling it to pieces with its cheliceræ. Scorpions cannot stand even a dry temperature much above 50° C., but fall into a sort of "heat coma," and soon die if the temperature be raised. The poison may be pressed out of the sting with the fingers or a pair of forceps, when it is found to be a milky white fluid with a very pungent smell, resembling that of formic acid.

* Proc. Roy. Soc., xlii. (1887) pp. 17-22.

Perineural Blood-lacuna of Scorpions.*—M. F. Houssay describes the so-called spinal artery, or perineural blood-lacuna of scorpions, and a glandular organ annexed thereto. He finds that the structure in question is really a lacuna and not a proper artery; the so-called annular artery and appendicular artery are dilatations of the lacuna of the cephalothoracic mass; an injection into the lacuna of the nerve chain is largely found on the dorsal surface of the chain, in the midst of the connective tissue without differential walls, but a little makes its way into the abdominal portion of the chain, and enters another longitudinal lacuna which lies on the ventral surface. Along the nerve chain, and not unlike the spinal artery, there is a white glandular organ, which in the fresh state is spongy; the blood forms a rich and irregular plexus in it. The close connections between it and the blood system, together with its abundant circulation, lead to the suggestion that it is a depuratory organ. Against this, however, must be set the fact that no crystals or concretions have yet been observed in it.

Structure of Pseudoscorpions.†—Herr A. Croneberg has a preliminary notice of the results of his work on the anatomy of Pseudoscorpions, based chiefly on a study of *Chernes Hahnii;* the anterior part of the rostrum consists of an almost transparent chitinous membrane, which projects in the form of an elongated oval upper lip. The edges of this lamella are fused in the anterior middle line, and are finely denticulated further back, where they are separated from one another. In the space between them there is a compressed lamella, the edges of which are also finely toothed. Posteriorly the two lamellæ pass into the short pharynx; the strongly chitinized wall of this part is produced into four wing-like ridges, which narrow the lumen. Numerous muscles serve as dilatators, while the contraction of the pharynx is effected by the elasticity of its walls.

The central mass of the nervous system is almost exactly like that of certain Acari (*Eylaïs, Trombidium*). The true stomach is a small enlargement, and, like the intestine, is invested by a clear small-celled epithelium; the chief mass of the viscera is formed by three large hepatic saccules, the two lateral of which break up into eight secondary lobes; the parts are connected by a vesicular connective tissue, which is especially developed in the more distal sections. The hinder half of the heart possesses a musculature arranged in numerous transverse segments, and the fissure-like orifices are in four pairs and confined to this hinder part. The gonads open by an unpaired orifice at the base of the abdomen between two transverse chitinous plates; the ovary has the form of a long unpaired tube beset on either side by a number of ovarian follicles; these appear to persist for some time after the ova have left them; the short vagina is surrounded by a close aggregation of unicellular glands, and receives also two long, much coiled, tubular glands; these correspond to the two thick packets of unicellular glands which are found in the male. The author has not been able to detect the spinning tubules reported by Menge to be present in this region; what appears to be a spinning organ lies in the cephalothorax, and consists of paired cylindrical tubules, four or five in number, which are grouped around a central canal; they open in the basal joint of the cheliceræ.

Anatomy and Classification of Phytopti.‡—Dr. A. Nalepa states that the cephalothorax of the gall-mites is unusually reduced, and besides the organs of the mouth carries only two distinctly quinquearticulate pairs

* Comptes Rendus, civ. (1887) pp. 520–2. † Zool. Anzeig., x. (1887) pp. 147–51.
‡ Anzeig. Akad. Wiss. Wien, 1886, p. 220. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 165–6.

of legs; the mouth-organs have the form of a more or less bent rostrum. At the extremity of the abdomen, on either side of the anus, there are two semilunar retractile plates which serve either as organs of attachment or to push the animal forwards. The sexual organs are unpaired, and their apertures lie just behind the last pair of legs; in the male the aperture has the form of a fissure surrounded by swollen margins and with a supporting plate; in the female it is closed by a superior and an inferior opercular plate. The rudiments of the sexual organs appear in the larvæ as solid cylindrical cell-bodies, and then proceed so far on the course of their development that it is possible to distinguish the sexes before the last month. Twenty-four species of gall-mites have as yet been closely investigated.

New Species of Mite.*—Herr G. Horvath found in barley certain mites which occasioned an endemic skin disease among the workmen. Dr. Carpeles describes and figures the larval and mature forms under the title *Tarsonemus intectus*. He believes that the form described by Flemming as *T. uncinatus* belongs to the genus *Pygmophorus*. Skin eruptions of this kind have hitherto been observed only in Hungary, with one exception.† Herr L. Orley found larvæ both in wheat and oats causing similar eruptions, and believes that the Hungarian species probably has a much wider distribution.

Development of Phalangida.‡—Dr. H. Henking, in his investigations into the developmental history of the Phalangida, has made use of a large number of *Opilio parietinus* and of *Leiobunum parietinum*. With regard to the ovarian ovum the author confirms the results of Blanc and Sabatier, and has satisfied himself of the presence of a distinct yolk-nucleus in the young ovarian ova; the whole of it is often surrounded by a yolk-zone, and is often constricted in the middle; it disappears as soon as larger formed yolk-masses appear in the egg. The young ovarian ova have the germinal spot placed on a semilunar body consisting of granules that can be stained, and which is of unknown function; as in a number of allied forms, eggs of moderate size have a distinct yolk-membrane. The ovum, when ready to be laid, is, like that of insects, without any indications of germinal vesicle or spot. The author is of opinion that there is no emission of semen at the time when the ova are being laid, and he thinks that the structure of the receptaculum seminis confirms this view. The mode of fertilization and the causes of the disappearance of the germinal vesicle are discussed at some length. When the ova are being laid a secretion is poured out from the glandular cells which invest the inner walls of the uterus and oviduct; this gradually hardens, and surrounds the egg as it were with a shell.

Passing to the history of the development of the laid ovum, the appearance of the first nuclei is described; the earliest indications of these are plasmatic networks of not inconsiderable size which arise separately from one between the yolk-spheres; treated with Flemming's chrom-osmium-acetic acid, they are seen to be distinctly granulated. It seems, then, that in the laid ovum of the Phalangida a number of new nuclei and cells appear by free nuclear and cell-formation. The cells the author proposes to call protocytes, and the nucleus protokaryon, as Ray Lankester's name of autoplast has already been used by Krause with a different signification. When treated with Flemming's fluid each of the networks is seen to become slightly darker near its centre owing to the presence of a number of

* Math. Term. Ertesitö, iv. (1886). Cf. Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) p. 428.

† Robin, C., Traité du Microscope, 1871.

‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 86–175 (4 pls.).

granules of various sizes, which are quite irregularly arranged. This darkening increases, and the granules approximate to one another, and the whole appearance gradually acquires greater homogeneity; in the homogeneous figures fine achromatic bands appear, which become more and more distinct; the achromatic substance becomes spindle-shaped, and the chromatin-spheres become collected at the equator; here they form a true equatorial plate. It is important to note, in connection with the idea that the nuclear substance arises spontaneously, that distinct chromatin-spheres may appear outside but close to an already formed spindle; these are certainly remnants from the ground-mass of the chromatic substance, and they may finally become connected with some of the granular groups. The author developes in detail the evidence in favour of free cell-formation.

With regard to the position of the nuclear rudiments in the egg it is important to note that they appear throughout the yolk-masses; in the early stages there are no indications whatsoever of fission. It cannot yet be decided whether or no the appearance of several protocytes is due to a larger number of spermatozoa entering the germinal vesicle. As soon as formed, but for a short time only, the protocytes increase by indirect nuclear division; in eggs of the fourth day they are numerous. From their divisions there finally results a nucleus with distinct limits which stains intensely with carmine and hæmatoxylin, and has no further internal structure than clear vacuolar spaces. The surrounding plasma becomes much more distinct, and stains (with eosin-hæmatoxylin) red, while the nucleus becomes blue.

Before the indirect divisions of the yolk-cells in the interior of the egg cease, the future ectoderm begins to be formed. The superficial cells take a perpendicular or oblique position in relation to the periphery of the egg; these cells divide, and while one of the two new nuclei becomes again the nucleus of a yolk-cell, the outer one more and more approaches the margin of the egg, and with its surrounding plasma becomes converted into a blastoderm-cell. Dr. Henking ascribes the difference in form of the outer and inner cells to the fact that the outer ones have a proportionately smaller opportunity of obtaining nourishment, and an increased supply of oxygen. The blastoderm-cells increase by division in the direction of the periphery of the egg. As so often happens in the development of the Arthropoda the blastoderm-cells wander to one side of the egg, and there divide with especial activity. The history of this stage is entered into with great detail.

The yolk is next described; in addition to a large number of small, homogeneous, highly refractive spheres there was a considerable number of larger spheres; others, intermediate in size, were less common. The larger spheres were not ordinarily homogeneous, but contained one granular nucleiform ball or homogeneous, rounded, or semilunar masses of higher refractive power; or the spheres were finely granulated, or contained a number of not quite round homogeneous corpuscles. The spheres appear to contain a fluid which is limited externally by a membrane. In addition to the formed yolk-elements there is also unformed paraplastic substance which aids in forming the fluid in which the yolk-spheres are suspended. The author gives a most detailed account of the yolk, many of the characters of which have been already observed in the ova of other Arthropods.

Dr. Henking proceeds to discuss the changes in the cell-nucleus, its disappearance, and "free nuclear and cell-division" in the various classes of the animal kingdom. He concludes that in all classes a temporary disappearance of the germinal vesicle has been observed, and suggests that first the chromatic substance is broken up, and that afterwards the whole vesicle becomes invisible. Observations on plants as well as

animals seem to show that protocytes are first observed as spots in the egg, which become more and more distinct, or as spindle-figures, or as aggregations of chromatin granules; in the first case the eggs are either living or have been only slightly acted on by reagents; the third case is probably the typical one, and if granules should be seen arranging themselves in a spindle, the second case would fall under it. It may be laid down as a law that the free formed primitive nuclei arise from the non-nuclear protoplasm first by the appearance of chromatin spheres, which gradually crystallize out from the plasmatic magma. These spheres either arrange themselves into a regular spindle-figure or fuse directly into a protokaryon. The evidence against the spindle arising directly from the germinal vesicle appears to the author to be complete. He is also of opinion that the law, "omnis nucleus e nucleo," will be shown to be contrary to the facts of the case. This lengthy essay, in which the observations of the author are given in the utmost detail, and shown to be often confirmatory of what has been discovered in other groups, concludes with some observations on the relations of the non-nuclear ovum to fertilization, and on the disappearance of nuclei in division and in adult cells.

ε. Crustacea.

Post-embryonic Development of Telphusa fluviatilis.*—Dr. F. Mercanti finds that when the embryos of *Telphusa fluviatilis* escape from the egg they are at a somewhat advanced stage of development, for they are in the *Megalopa* condition, and have the eyes already stalked and the ambulatory appendages completely developed. The author describes the changes undergone by the limbs: the abdomen of the young is remarkable for being more like that of the adult male than of the female. The history of the development of *T. fluviatilis* has some points of resemblance with that of *Astacus fluviatilis;* but the most striking likeness is between the young *Telphusa* and adult examples of the fossil *Pseudotelphusa speciosa* from the miocene deposits of Oeningen. Dr. Mercanti's comparison of these two species leads him to adopt the theory of Prof. Capellini, that the latter is an ancestral form of the species now living.

Crustacean Parasites of Phallusia.†—M. P. Gourret has found seven parasites in the branchial cavity or cloaca of *Phallusia mammillata* and *P. mentula* from the Gulf of Marseilles; they are all crustacean. Of two known species, *Doropygus* (*Notopherophorus*) *papilio* and *D.* (*N.*) *elongatus*, there are two varieties, called respectively *massiliensis* and *maculatus*. *Pinnotheres Marioni* sp. n. differs remarkably in the two sexes. There are a few notes on *Pontonia phallusiæ*. The larvæ of a new species of *Cryptoniscus* were observed, in which the body was fusiform, the sides of the abdominal segments were prolonged into spines, one pair for each of the first two rings, and two pairs for the others; the lower antennæ carry two flagella, one of which is much reduced; the gnathopods are not forceps-like, and the dactylopodites were simple hooks. *Leucothoe spinicarpa* and *Lichomolgus forficula* complete the list.

'Challenger' Brachyura.‡—Mr. E. J. Miers confines his report on the Brachyura collected by H.M.S. 'Challenger' to the systematic aspect of the subject; the groups richest in new genera and species are the Oxyrhyncha

* Arch. Ital. Biol., viii. (1887) pp. 58–65.

† Comptes Rendus, civ. (1887) pp. 185–7.

‡ Reports of the Voyage of H.M.S. 'Challenger,' Monograph xlix. (1887) l. and 362 pp., 29 pls.

and Oxystomata; no brachyurous crab occurs in the deepest abysses of the ocean (beyond 2000 fathoms) and but very few at depths below 500 fathoms. Some of the deeper water forms were found to have a wide geographical range. Among the Pinnotheridæ the new subfamily of Hexapodinæ is instituted for those curious forms in which the fifth ambulatory legs are rudimentary or aborted. The Leucosiidæ it is proposed to divide into the Iliinæ and the Leucosiinæ.

Structure of Muscular Fibres of Hedriophthalmata.*—M. R. Koehler states that in the hedriophthalmatous Crustacea the myogenic cell is not entirely occupied by the contractile substance, and that a more or less considerable portion of the protoplasm inclosing the nuclei persists in the adult animal; the muscular bundles are remarkable in that the contractile substance occupies the central part of the cell, and the protoplasm the periphery. The muscular fibrils are grouped into small columns, which are very distinct, but their number, size, and relative disposition vary considerably. Among the Amphipoda, *Gammarus pulex* has the primitive cylinders very distinct; they are of some size, and to the number of ten to fifteen occupy the central part of the cell; in *Talitrus saltator* the cylinders are smaller, but more numerous; in *Dexamine spinosa* they are very small and closely packed, and appear in section as fine granulations. Among the Isopoda, *Idotea linearis* has numerous cylinders, rather closely packed, and forming a central group which is surrounded by the richly nucleated protoplasm of the myogenic cell; in *Sphæroma serratum* the cylinders are very large, the protoplasm very abundant, and the nuclei of considerable size. In *Ligia oceanica* the myogenic cells fuse with one another, and the primitive cylinders are grouped in such a way as to leave an interval between themselves and the membrane of the cell; this interval is occupied by protoplasm, and the nuclei are small and not numerous. In *Conilera cylindracea* the primitive bundles are relatively colossal in size; the myogenic cells give rise to polygonal areas which may be as much as 0·08 mm. long and 0·025 mm. wide. In the parasitic Isopoda the primitive bundles are also large. The number of primitive cylinders and the size of the elements does not, in the Hedriophthalmata, appear to increase in direct relation to the size of the animal, for they are common in *Conilera*, smaller in *Cirolana*, and still smaller in *Ligia*, while in Amphipods they are larger than in *Gammarus*. The variations in histological structure are seen to be less remarkable in Amphipods than in Isopods, and in these latter orders there are often considerable differences in the size of the muscle-cells possessed by one and the same animal.

Development of Porcellio scaber.†—Dr. W. Reinhard comes to results essentially different from those of Prof. Bobretzky and Herr Nusbaum as to the formation of the germinal layers of *Porcellio scaber;* it may be noted that he has had the opportunity of studying phases of development earlier than those seen by the naturalists just mentioned. The nucleus of the egg-cell divides, and forms amœboid cells with part of the protoplasm; these, as they multiply, make their way to the periphery of the egg; when they reach it they become many-sided, and are converted into the cells of the ectoblast; this is not at first a thick layer but consists of several "islands." Under these several layers of cells appear, and between them the spaces become gradually filled up; the cells underlying the ectoblast form the primary endoderm, which only gradually becomes differentiated into mesoderm and endoderm.

The midgut is formed as an independent portion from the endodermal

* Comptes Rendus, civ. (1887) pp. 592–5. † Zool. Anzeig., x. (1887) pp. 9–13.

cells in the anterior region of the germ; its wall gives rise to two forwardly directed outgrowths which flatten out and grow up on either side; these lateral walls rapidly fuse in the anterior region; before they do so, however, they give rise to two hepatic saccules. The hinder part of the gut partly closes up, but the median portion still remains open, and in contact with the nutrient yolk. The anterior side of the hindgut now lies very close to the midgut. The author was unable to find any of the so-called yolk-cells; the cells of the primary endoderm do not lie within but between the yolk-spherules, and the remarkable absorption of the yolk is only effected by the differentiating cells of the endoderm, which form the midgut and liver-saccules.

In *Porcellio* as in *Oniscus* (described by Nusbaum) the second pair of hepatic outgrowths is formed by longitudinal division of the outgrowths of the first pair.

Cepon.*—MM. A. Giard and J. Bonnier discuss the characters of the genus *Cepon*, a Bopyrid from Mauritius, which was discovered in 1840, but whose host was unknown; in 1881 it was found at Naples in *Portunus arcuatus*. Two new species have lately been discovered at Concarneau in *Xantho floridus* (*Cepon pilula*), and at Wimereux, where *C. elegans* is not very rare in *Pilumnus hirtellus*; the parasite is found in the upper part of the branchial cavity, and generally its hosts are young examples. The forms figured by Duvernoy as males are really young females not entirely transformed; the species found on Cancridæ hold to the *Cepon* of the Portunidæ the same relation as in *Entione* is held by *Cancrion* to *Portunion*; they are less profoundly modified just as are their hosts. The embryo of *C. elegans* has a considerable resemblance to that of *Phrynus paguri*; in both a young male and in *Entione* a *Cryptoniscus*-stage has been observed to succeed the first larval form, and as this has been found in *Bopyrina virbii* and in *Phrynus* this second larval stage may be supposed to be common to all the Bopyridæ; it is in this stage that they probably make their way into their hosts.

'Challenger' Isopoda.†—Mr. F. E. Beddard, who has already published a preliminary report on the 'Challenger' Isopoda here collects and illustrates his accounts. It is proposed to form a new genus, *Ianthopsis*, for *Ianthe bovalli*; and a few species are here described for the first time. Deep-sea Isopoda appear to be distributed very unevenly over the floor of the ocean, long stretches being altogether devoid of them. Thirty-four of the deep-sea species are blind, while in eighteen there are well-developed eyes; but of the eleven specially deep-sea genera representatives of two alone had eyes; the reason for some species retaining their eyes while others lose them on migration into deep water is perhaps to be sought for in the difference of the length of time that the respective species have inhabited great depths. Among Isopods the deep-sea fauna comprises many species which are larger than their shallow-water representatives, the colossal *Bathynomus giganteus*, described by Prof. Milne-Edwards, measuring nine inches in length. Deep-sea species often exhibit a great development of spines on the body; this is most noticeable among the *Arcturi*, but it is perhaps a character dependant rather on temperature than depth, for it has been observed in the species which inhabit cold regions.

Anatomy of Internal Male Organs of, and Spermatogenesis in Cypridæ.‡—Dr. F. Stuhlmann finds that the four testicular tubes of either

* Comptes Rendus, ciii. (1886) pp. 889–92.

† Reports of the Voyage of H.M.S. 'Challenger,' Monograph xlviii. (1887) 178 pp., 25 pls.

‡ Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 536–69 (1 pl.).

side unite, in the Cypridæ, at the vas deferens; the so-called fifth or subsidiary testicular tube is only a cæcal appendage of the vas deferens which serves as a kind of reservoir for the spermatozoa; the vas deferens traverses the mucous gland or ejaculatory apparatus, and its cæcal appendage is not formed till a relatively late period in development. In quite young animals the testicular tubes only contain a syncytium and large cells; later on small cells, spindle-shaped cells, and finally spermatozoa appear. The whole of the vas deferens, inclusive of the ejaculatory apparatus, is gradually differentiated from a single homogeneous tubular mass. The nuclei of the syncytium at the tip of the tubes becomes the vesicular nuclei of the large cells; these divide several times, and more often in *Cyproïs* than in *Cypris punctata*. The nucleus of the small cell formed by division is spindle-shaped. In *Cyprois* it appears as if several spindle-shaped cells remain connected together. The nucleus becomes the central filament of the spermatozoa, in the formation of which only one nucleus takes part. In the glandular portion of the tube the spermatozoon increases in thickness and the central filaments become invisible. Owing to the movement of a spiral fringe the spermatozoon gradually passes into the upper portion of the vas deferens, and finally surrounds itself with a hyaline envelope; it is now ready to pass out, but is still almost immobile; the power of movement is only obtained in the receptaculum seminis of the female, where the hyaline envelope becomes striated.

Parasitic Copepoda.*—Mr. R. Rathbun describes various species of the genera *Pandarus* and *Chondracanthus;* he commences with a detailed description of *P. sinuatus*, which is only known from the imperfect account given of it by Say in 1817; *P. Smithii* is a new and large species, resembling in appearance rather *P. Cranchii* than *P. sinuatus;* three new species of *Chondracanthus* are described; *C. galeritus* is often found in the mouth of the common flounder (*Paralichthys dentatus*), and appears to correspond more nearly with the European *C. cornutus* than with any described species; *C. phycidis*, from the gills of the common hake (*Phycis tenuis*), has the anterior antennæ small and the thoracic appendages stout; *C. cottunculi* was found in the gill-cavity of two species of *Cottunculus*. The author confines himself to describing these species, and offers no remarks of more general interest.

New Lernæan.†—Prof. C. Claus describes *Lernæascus nematoxys*, a hitherto unknown Lernæan; it lives beneath the scales, especially of the pigmented side, of *Solea monochir*, is 8–10 mm. long, and has the appearance to the naked eye of a small Nematode. The anterior end is recognizable by the insertion of the antennæ, and the hinder by the two furcal processes; the abdomen is only 1 mm. long. The prehensile antennæ terminate in strong hooks; the tripartite entomostracal eye is perfectly retained. The mouth-organs consist of a sucking proboscis armed with two reversed hooklets and of two powerful maxillipedes; the mandibles are aborted, and the maxillæ are represented by stylet bristles placed outside the proboscis. Three pairs of limbs, consisting of minute feet, originate far apart; the first two are still biramose, but the third are simple wartlike tubercles furnished with two setæ. A character acquired by adaptation and quite peculiar to the genus is the presence of about fifty pairs of dorsal and a similar number of ventral scale-like finely striated elevations which extend over the whole of the thorax, and are of

* Proc. U.S. Nat. Mus., 1886, pp. 310–24 (7 pls.).

† Anzeig. Akad. Wiss. Wien, 1886, p. 231. Cf. Ann. and Mag. Nat. Hist., xix. (1887) pp. 241–2.

essential service in the gliding movements executed by the parasite under the scales of its host. The stage described is that of an egg-producing female; males and females in the copulatory stage are scarcely one-third the length of the pregnant female, and nearly approach the type of the free-swimming Copepoda; the larger males are almost normally segmented, and have two pairs of swimming feet, modified to act as clinging organs; the smaller and more feebly constructed female has the segmentation reduced in the thorax and abdomen. The testes are remarkable for being moved down into the terminal segment, a change which obtains in the Argulidæ, but not among Copepods; the spermatophores are remarkably large, and extend as far forward as the antepenultimate thoracic segment. The prehensile antennæ are of the type of the Corycæidæ, and the two winglike plates on the back of the second thoracic segment remind one of the Pandaridæ; these are somewhat aborted in the ovigerous female, remaining as two pointed chitinous pieces.

Vermes.

a. Annelida.

Muscular Fibres of Polychæta.*—M. Jourdain has examined the minute structure of the muscles, especially those of the integument, of various species of Polychætous Annelids. Though the muscular fibres vary considerably in form they may be referred to two types: some are almost cylindrical, others distinctly lamellar; these are connected by intermediate types. The fibres consist of a contractile substance remarkable for its intense coloration and its homogeneous aspect, and of a nucleus which is accompanied by a more or less abundant protoplasmic body. In this contractile substance it is generally impossible to discover either transverse or longitudinal striæ; staining reagents, and especially hæmatoxylin, reveal segments which are alternately clear and dark, and which give the fibre an appearance "plutôt zébrée que striée;" these false striations correspond to true thickenings of the muscular substance, and have nothing in common with the striæ of vertebrate or arthropod muscle. A true striation has, however, been detected in *Protula intestinum*, which for fineness and regularity is comparable to what is seen in mammals; it can only be detected with the aid of immersion lenses. It is to be noted that tubicolous worms of the type of *Protula* are remarkable for the rapidity with which they contract and inclose themselves in their tubes.

Life-history of Thalassema.†—The development of a new species, *Thalassema mellita*, has been traced from the ovum to the adult by Mr. H. W. Conn.

The ova are very minute and remain free in the cœlomic fluid for a considerable time before entering the two pairs of anterior nephridia, or "sexual pouches." As the animal when very young enters and remains in the shell of *Mellita*, no copulation takes place. The vitelline membrane is excreted from the egg, which is, when discharged, filled with yolk-granules, and within this membrane is a peculiar modification of the superficial protoplasm, having the appearance of closely set, short cilia.

The eggs are not spherical, having one pole much less convex than the other, but immediately upon the entrance of a spermatozoon the egg becomes spherical. The vitelline membrane becomes raised up over this flattened area, and the polar bodies are here found—not until after the

* Comptes Rendus, civ. (1887) pp. 795–7.

† Stud. Biol. Lab. Johns-Hopkins Univ., iii. (1886) pp. 351–99 (4 pls.). See also this Journal, 1884, p. 381.

entrance of a spermatozoon. The author considers that the space between the egg and the vitelline membrane is filled, not with a liquid, but with a gelatinous substance, which shows radiating striæ. After the extrusion of the two polar bodies, the true fertilization takes place, as is evidenced by the appearance of a large "aster" in the ovum.

The segmentation is perfectly regular, despite the quantity of yolk present, and results in a morula. When this has been converted into a blastosphere, cilia appear over all the egg, with the exception of a small area from which the endoderm will be formed. This layer arises by a process of modified invagination. As the cells become slightly inpushed, they increase in size and divide up, so as to form a solid mass. Thus there is no blastopore. A few of the ectoderm cells at the pole opposite the blastopore area, i. e. where the endoderm has been formed, are larger than the rest, and have long immobile cilia: this is the commencement of the supra-œsophageal ganglion. The body-cilia gradually become condensed to a ring round the body.

A cavity now appears in the endoderm, which will soon communicate with the exterior by a pore—the mouth. The larva elongates in a direction oblique to the axis through the ganglion and blastopore area. The archenteron becomes constricted into œsophagus, stomach, and intestine, which last elongates, attaches itself to the body-wall, and then communicates with the exterior. Thus, "neither the œsophagus nor the rectum is formed as a distinct invagination, i. e. there is neither true stomodæum nor proctodæum." The author refers to Hatschek's statement that the intestine of molluscs is an endodermal formation.

The larva has now become a trochosphere. The preoral band of cilia is carried by large cells, differing histologically from the remaining ectoderm cells, and there is a similar postoral band. There is also a broad band of cilia extending along the median ventral line, the cells bearing them being the rudiments of the nerve-chain. The cells of the ectoderm are crowded with peculiar "wormlike" unicellular glands, which produce a strong secretion, rendering staining difficult. In the ectoderm, also, are numerous muscle-cells, bearing a great resemblance to the epithelio-muscular cells of Cœlenterates.

The histological characters of the different regions of the alimentary tract are described, and the "ciliated ridge" which probably gives rise to the ciliated groove of the adult. The mesoderm consists partly of "mesenchyme," as in Echinoderms, and partly of true mesoderm, as in Annelids.

The later history of *Thalassema* is similar to that of *Echiurus*. The larval segmentation is very conspicuous, especially in the nerve-chain; this is formed as in *Lumbricus*. The ventral setæ are formed in small mesodermal sacs, which later on acquire an opening through the ectoderm to the exterior. The anal pouches arise as ectodermal invaginations, and funnels gradually arise. Mr. Conn was unable to find any trace of the larval excretory organ described by Hatschek for *Echiurus*.

The author, from the developmental history, agrees with the theory that the Gephyrea are extremely modified Annelids, while *Polygordius* is at the opposite end of the group. He would separate the Sipunculidæ from the Echiuridæ; and *Bonellia* would have to be placed apart from the latter, owing to its very different mode of development.

Several theoretical points are touched upon in this paper; one of them refers to the polar bodies. The author considers that the spermatozoon must exert a certain amount of influence on their formation, for if no spermatozoon enters the egg no polar bodies are formed. This has been

noticed in the case of two species of oyster, and in certain bony fishes. From various facts observed he considers that they are not the male portion of the egg-cell. The regular segmentation of the ovum is to be regarded as resulting from its free life; in most of the groups of the animal kingdom there are certain members whose eggs are not protected in any way, but which float freely from the first, and there segment regularly; whereas eggs which are protected either in capsules or in the parent's body and so on, segment irregularly. The cause of this is mechanical, and is not so much due to the yolk present, as to gravity.

Pelagic Annelids of the Gulf of Algiers.*—Dr. C. Viguier devotes the second part of his essay on the lower animals of the Gulf of Algiers to the pelagic Annelids, and to some general considerations on the constitution of the members of their order.

The pelagic Annelids may be divided into several groups; some, like the Heteronereidæ and the Syllidæ, which exhibit no alternation of generation, are for a short time only pelagic; others are pelagic for the whole course of their existence, but this is very brief,—they are the sexual stolons of Syllids with alternation of generation. The Annelids that are essentially pelagic all belong to the Alciopidæ or Phyllodoceidæ, with the latter of which may be associated *Tomopteris* and *Sagittella*. Of the forms enumerated by the author, five—*Maupasia cæca* g. et sp. n., *Iospilus phalacroides* g. et sp. n., *Alciope microcephala*, *Vanadis heterochæta*, and *Amblyosyllis algefnæ*—are new.

The author is of opinion that the head of an Annelid is typically composed of a single ring, formed directly from the trochosphere; this trochosphere first buds off the pygidium, which grows and becomes segmented. When the grooves which mark off the segments become apparent the first is seen to pass behind, or at least by the mouth; in cases of simple fissiparous reproduction, as e. g. in *Syllis fiumensis*, one of the rings of the primitive animal is very distinctly seen to be transformed into the head of the secondary individual, and alone to form its head.

On the basis of the conclusions to which he arrives M. Viguier tries to clear up the present confusion in the nomenclature of the parts of the Annelid; if we put aside the branchiæ, we may say that each segment of a free-swimming Annelid has only, on either side, a foot formed of a single or of two projections (dorsal and ventral). This foot normally carries a dorsal cirrus, which may be converted into an elytron, and a ventral cirrus below. These cirri may become greatly developed, or, as well as the foot itself, may become more or less completely atrophied. The cirri of the first or of the first few postcephalic rings often differ more or less profoundly, in form and development, from those of the rings which support them; generally speaking, their importance is, in one animal, in inverse proportion to that of the corresponding foot. He sees no reason for a change of names, and refuses to make use of the expressions tentacle or tentacular cirrus; where a note is necessary it is better to say that such or such cirri (using their number in order) are tentacularized.

The author commences his systematic account with the Phyllodoceidæ and the Alciopidæ, for between these families he is unable to draw any absolute line of demarcation. Accounts are given of *Pelagobia longocirrata*, which, unlike Greef, he does not place with the Syllidæ; of *Maupasia cæca*, the representative of a new genus and species, but the generic and specific characters are not technically distinguished in the account; *Hydrophanes Krohnii*; *Pontodora pelagica*, which, again, the author removes from among

* Arch. Zool. Expér. et Gén., iv. (1886) pp. 347–442 (7 pls.).

the Syllidæ, where it was placed by Greef; *Iospilus phalacroides* g. et sp. n. is an amended name for what the author first called *Ioda microceros;* what were taken for antennæ have since been found to be the palps. Some additions are made to Greef's account of *Phalacrophorus pictus.* Descriptions and notes are given of *Asterope candida*, *Alciope microcephala* sp. n., *Vanadis heterochæta* sp. n., and *Rhynchonerella capitata.*

Of the Tomopteridæ, which are rare in the bay, and generally, when found, are young, an account is given of *Tomopteris Kefersteinii.*

Of the Typhloscolecidæ, which are very rare, *Sagittella Kowalevskii* was alone recognized; of the Aphroditidæ there was a *Polynoe*, which may be pelagic, and if so may be called *P. pelagica.* Of the Eunicidæ, an account is given of *Ophryotrocha puerilis.* In the commencement of his account of the Syllidæ the author has some critical remarks on Prof. McIntosh's description of *Syllis ramosa;* of the forms without alternation of generation *Amblyosyllis algefnæ* sp. n. is described; of those with alternation, additions are made to Langerhans' account of *Virchowia clavata*, of which its original describer found only one example at Madeira, of *Autolytus prolifer*, and of *Myrianida fasciata.*

In his descriptions of the head the author recognizes on the lower surface, at the level of the mouth, the palps; in some Syllidæ there are occipital appendages which are called the ciliated lobes, and all the other appendages are anterior—either median, superior, or inferior; in the pygidium there are the lateral anal cirri, and the median pygidial appendages; on all the other segments, among which the buccal segment of authors is included, there may be a pedal mamelon, and a dorsal and a ventral cirrus.

Australian Polychæta.*—Of the family *Syllidæ* only two species have been described from Australia. Mr. W. A. Haswell describes seven new species.

Syllis corruscans is very remarkable from the presence of striated muscular tissue in the gizzard—"a tissue which has never before been described as occurring in Annelida." In this species there are innumerable unicellular glands in the hypoderm. The histology of the various organs is described. In the gizzard there is a thin cuticle, below which is the epithelium; an external and internal layer of ordinary non-striated muscle, and a middle layer of striated muscle arranged radially, the fibres of which present a nucleated protoplasmic core, with very marked striæ in their contractile portions. These rows of striated muscle have hitherto been regarded as transverse rows of glands. In the hinder portion of the intestine the epithelium contains numerous greenish concretions, which the author regards as being "of a uric character." The "segmental organs" (which the author differentiates from A. G. Bourne's "nephridia") are curved brown tubes opening on the ventral surface close to the parapodia. As usual, a combination of fission and budding occurs; the anterior dark-coloured region is female; the posterior orange-coloured portion is male; and this male form differs in many respects from the complete animal. *Syllis kinbergiana* shows many points of resemblance to *S. umbricolor*, from which it differs by the presence of three acicula in the parapodia. It is also related to *S. gracilis* and *S. hamata* and others. *Syllis tæniæformis* has uniramous feet, with three acicula, and twelve compound setæ, which have a short blade, bifid at the apex. *Syllis schmardiana* is somewhat similar to *S. erythropsis* and *S. vittata* Gr. In this species also striated muscular fibres occur in the gizzard; but the striæ are very few. *Syllis nigropunctata* is a small form, not unlike *S. variegata* Gr. *Gnathosyllis zonata* was in-

* Proc. Linn. Soc. N. S. Wales, x. (1886) pp. 733-54 (6 pls.).

complete posteriorly; no striations were observed in the radiating muscular fibres of the gizzard. Of the genus *Staurocephalus* a new species, *S. australis*, is described. *Eulalia quadrocula* is related to *E. microceros* Clap., but the new species has four pairs of eyes. *Psamathe* (?) *crinita* may turn out to be a type of a distinct genus. *Siphonostoma affine* is peculiar in possessing a pair of very long narrow cylindrical glands opening on the lateral dorsal surface of the body, just behind the head. These glands extend through a considerable portion of the body, have delicate walls, and contain cells inclosing small greenish particles. *Halla australis* is rich orange in colour, and from it a purple pigment is extracted by alcohol. There are seven pairs of jaws, some toothed, others not toothed. This species resembles *Nereis parthenopeia* Della Chiaje, but the latter has not the long whip-like setæ. Imbedded in the substance of the nerve-cord, in the anterior segments, are a series of eight or ten oval vesicles. Each is inclosed in a fibrous capsule, pierced by nerve-fibres, and contains a spherical solid body; the author suggests that they may be a rudimentary form of otocyst.

Conodonts.*—Herren J. V. Rohon and K. A. von Zittel have examined the structure of those enigmatical bodies which Pander regarded as the teeth of cartilaginous fishes of Silurian times, and find that all the forms consist of parallel-layered conical laminæ, arranged one over the other, and sometimes traversed by fine radial canals. The structure of these Conodonts has, then, nothing in common with the teeth of any fish, nor with the corneous teeth of Cyclostomi, nor can they be regarded as the lingual denticles of Molluscs, hooks of Cephalopods, or fractured points of Crustaceans; they do, however, agree admirably in form and structure with the buccal apparatus of Annelida and Gephyrea. Their great multiplicity of form leads us to suppose that they belonged to numerous genera and species, and consequently to the inference that in the Palæozoic times the shores of the sea were peopled with a great abundance of worms of very different kinds.

B. Nemathelminthes.

Embryology of Nematodes.†—M. P. Hallez has a note on the development of the mesoderm in round-worms; the layer starts from two cells which undergo division. As they do so the two mesodermic cells become smaller and smaller, while retaining their characteristic granular aspect; the two first cells grow larger and become very distinct, and will give rise to the gonad; by developing two cells posteriorly, they form the commencement of the genital ducts. Later on the two primitive cells are replaced by a small cellular mass, which is the ovary or testicle. The author has as yet been unsuccessful in making out the formation of the excretory apparatus.

The 16-stage appears to be important; in it there are four endodermal cells, of which the anterior and posterior will give rise respectively to the fore and hind parts of the intestine, while the two median give rise to the median part; there are the two initial cells of the mesoderm, two sexual cells, and eight ectodermal cells, of which the central is probably the point of departure for the cells of the central nervous system. Thus, from the beginning of segmentation, all the regions and all the organs of the new being are indicated.

* SB. Bayer. Akad. Wiss., 1886, pp. 108–36 (2 pls.).
† Comptes Rendus, civ. (1887) pp. 517–20.

Heterogamy of Ascaris dactyluris.*—M. Macé describes the development of *Ascaris dactyluris*, which live at the expense of the tissues of their mother, till its body is reduced to a mere sac. The young are now well advanced in development, the digestive apparatus being complete, and the reproductive organs containing products which are apparently matured; all these embryos are, without exception, females. The uterus is single and not double as in the parent form.

We have here a case comparable seemingly to that mode of development of the larvæ of the Cecidomyiæ which has been called pædogenesis, but it is to be noted that the reproductive individuals of these Nematoids appear to be less advanced than the viviparous larvæ of the Diptera. However, the author has not been able to see these eggs undergo development, but he believes that they escape to damp earth, and intends to investigate the question; if he proves to be correct in his supposition we shall have a case similar to that of *Ascaris nigrovenosa*, where the female gives rise to hermaphrodite ova; or, in other words, we shall have among Nematoids another instance of alternation of generations.

Heterodera Schachtii.†—Herr A. Strubell finds that *Heterodera* is a true Anguillulid, and stands nearest to *Tylenchus;* the sexes are distinguished by a remarkable dimorphism, the male having the characteristic nematoid form, and the adult female being spherical, and incapable of movement. The cylindrical body of the male is from 0·8–1·2 mm. long; the anterior part has a cap-like elevation which is separated from the rest of the body by a circular groove; the cuticle is distinctly ringed transversely, the rings extending all round the body, and being only broken at the lateral areas. The cephalic cap is to be regarded as the morphological equivalent of the lips. The lateral areas are broad and are divided longitudinally into three divisions; there is only one excretory vessel. There are four muscular areas, and in each there is seen, on transverse sections, five muscle-cells; the constituent elements are rather spindle-shaped than rhomboidal, and the medullary mass exhibits no processes of any kind. In Schneider's classification, therefore, *Heterodera* belongs to both the Polymyaria and the Platymyaria, and affords, therefore, a fresh proof of the untenable character of Schneider's classification. No anal nerve-ganglion could be made out.

The spine in the buccal cavity is stilet-shaped and hollow, and has at its base three knob-like thickenings; it is moved by three pairs of muscles. The last division of the œsophagus is chiefly distinguished by the presence of remarkably large nuclei. When the spermatozoa are in movement they emit extraordinarily long pseudopodia, which take on the most various forms.

The female of *Heterodera* has the form of a lemon with the poles drawn out; one of these processes is pretty sharply marked off from the chief mass, and is seen to be the cephalic portion by the presence of a spine; the dorsal is always more strongly curved than the ventral surface; the anus lies near the vulva and dorsally. In place of the transverse annellation of the cuticle there are five knobs and ridges which generally take a horizontal direction; the lateral areas cannot be detected from the exterior. The genital apparatus consists of two tubes, which unite to form a common vagina; between the oviducal and uterine portions of each tube there is a receptaculum seminis.

The ovum is bean-, or kidney-shaped, and is inclosed in a firm structureless shell; the yolk-elements are very large. Eggs at various stages of

* Comptes Rendus, ciii. (1887) pp. 306–8. † Zool. Anzeig., x. (1887) pp. 42–6, 62–6.

development may be found in the uterus; segmentation is irregular. As noticed by Goette, two large round cells lying symmetrically in the ventral region and near the middle of the body appear early; they disappear as soon as the rudiments of the gonads become apparent. Histological differentiation of the various organs is effected very rapidly. In the post-embryonal development of *Heterodera* there is a metamorphosis; the appearance of a pupa-stage in the male is especially interesting. The first larval form is an agile worm, very much like the male in organization; this takes to a parasitic mode of life—in beet-root—and the second larval form appears as a flask-shaped body; this grows and the root of the plant incloses it. Up to this stage the animals are sexually indifferent, but differences soon begin to be apparent; the greatest changes are now effected in what will be the males; the length of the whole development depends on external conditions, chiefly warmth and dampness; it is generally effected in four or five weeks. The history of the metamorphosis is unlike any known among Nematodes, or even in Acanthocephala; among the Arthropoda, the greatest resemblance is shown by the Coccidæ, where too the female remains at a larval stage.

Asconema gibbosum.*—Prof. M. Braun, in a notice on this remarkable Nematode, heads his remarks with "*Atractonema gibbosum*" and states that in the separate copies of his paper, Professor Leuckart made a MS. change of the generic name, as *Asconema* was already in use for a fungus.

Structure and development of Cysts of Echinorhynchus.†—M. R. Kochler comes to conclusions, with regard to the cysts of *Echinorhynchus angustatus* and *E. proteus* found in the barbel, different to those published by M. Mégnin five years since. The smallest cysts, which are not more than some tenths of a millimetre in diameter, appear as small white dots on the surface of the intestine or of the peritonæum. They have a thick envelope formed of several concentric layers of a connective tissue, rich in nuclei, and there is a central granular mass formed by the union of a large number of small cells. This cellular mass, which is spherical in the youngest cysts, becomes ovoid, and is then differentiated to give rise to a proboscis of an *Echinorhynchus* on which the characteristic hooks appear. The hooks are formed from before backwards. At the hinder extremity of the proboscis there soon appears a small bud which gradually elongates; this is hollow and contains a central cord—the genital cord. The posterior region is reduced to a very delicate prolongation, which is rounded and a little swollen at its extremity, but is much narrower than the proboscis of which it appears to be merely an unimportant appendage. In no case was the cyst found to contain an animal provided with lemnisci, and if these organs do appear within the cyst they can only do so much later on. They arise behind the proboscis, and have the same structure as in the adult. When the largest cysts are examined but few are found to have their elements intact, nearly all are hard, and can only be broken or cut with difficulty. The rudiment of the *Echinorhynchus* appears to have undergone a special degeneration which has made it hard and friable.

The *Echinorhynchi* which are found in the digestive tract of the barbel, fixed against the walls of the intestine, arise without doubt from larvæ which have passed their early stages in a *Gammarus* or an *Asellus*. In other words, the cysts found in the peritonæum do not give rise to the parasites found in the intestine. The origin of the former still remains unknown, and suggestions as to it are all that can yet be made.

* Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 212–3.
† Comptes Rendus, civ. (1887) pp. 710–2.

γ. Platyhelminthes.

Leuckart's 'Die Parasiten des Menschen.'*—Prof. R. Leuckart has published a further instalment of the second edition of his classical work on human parasites; in this the development and structure of *Bothriocephalus* continues to be described. In addition to the well-known *B. latus* there are accounts of *B. cordatus* and *B. liguloides* (= *Ligula mansoni* Cobbold). In an appendix of additions and corrections the author brings this volume, the issue of which began in 1879, up to date, giving interesting information regarding the increase in our knowledge of parasitic Protozoa, and a *résumé* of the advances in the history of the Cestoda. The structure and life-history of the Trematoda is commenced in the first few sheets of the next part. So far as Protozoa to Cestoda are concerned the work is now accessible to those who read only English.†

Anatomy of Bilharzia.‡—M. J. Chatin states that the fine spines found on the integument of *Bilharzia* are more numerous and better developed in the female than in the male; these spines have, no doubt, a greater morphological value than has ordinarily been attributed to them, for they must play a certain part in the lesions of the capillaries which are caused by the presence of these parasites. The muscular body-wall is only moderately thick as compared with that of other Trematodes. The œsophagus, which is at first narrowed, widens out, and becomes curved; where the two limbs of the stomach join there is a small median cæcum, which ought properly to have the name of intestine; its slight development, and its variation in sexes and individuals show that it is of no great value physiologically; unlike what happens in most of its allies, *Bilharzia* has the enteric muscular layers poorly developed, even in the region of the pharyngeal bulb. As M. Chatin has been able to detect in some examples of *Distomum lanceolatum* a tendency to the approximation of the two cæca he thinks that *Bilharzia* may be allied to the typical genus of the Trematoda. An account of the excretory and generative apparatus is reserved for another communication.

Excretory and Reproductive Systems of Bilharzia.§—M. J. Chatin has made a careful study of the excretory apparatus and reproductive organs of *Bilharzia*, in regard to which our knowledge has been hitherto almost confined to the original, and apparently inexact description of Bilharz.

(*a*) The well-developed excretory system has a posterior contractile orifice, into which there opens an elongated reservoir, receiving the two lateral and single median vessels. The main vessels, which are lined by a definite membrane, divide and ramify, with a marked reduction in the male.

(*b*) When macerated in dilute alcohol, the testes separate from one another, and are seen peripherally to consist of fine tubules continued into the seminal ducts. These extend to the vas deferens, which before passing into the "gynæcophorous canal" dilates into a simple prostatic, certainly not penial sac.

(*c*) The small, lateral ovary of this remarkable dicœcious Trematode is masked by a portion of the uterus, is slightly four-lobed, and connected by a short oviduct with the junction of the albumen duct and the stalk of the shell-gland. (*d*) The albumen glands form numerous lateral lobes com-

* 'Die Parasiten des Menschen,' Bd. i. Abth. 1, pp. 855–1000, title-page and xxxi. pp.; Bd. i. Abth. 2, pp. 1–96.

† 'The Parasites of Man,' translated by W. E. Hoyle, 8vo, Edinburgh, 1886, 771 pp. and 404 figs.

‡ Comptes Rendus, civ. (1887) pp. 595–7.

§ Ibid., pp. 1003–6.

municating with a central canal, which dilates before ending near the oviduct. The structure of the gland recalls that of Diplozoon. (*e*) The irregularly conical shell-gland, prolonged superiorly, and borne on a short broad stalk. It is covered with a connective-tissue membrane, lined by a thick epithelium, and often contains only a single egg as in several Polystomeæ. (*f*) The adjacent uterus is first expanded, then narrowed, again dilated and again contracted before opening in a small depression, protected by a musculo-cutaneous fold. (*g*) In the region occupied by the oviduct, the albumen duct, the uterus, &c., there is a small blackish tract directed dorsally, and apparently representing the canal of Laurer, though without visible external aperture.

(*h*) The seminal fluid passing from the ejaculatory duct probably flows into the gynæcophorous canal, and is led by the ventral groove in the female to the opening of the uterus. The almost permanent copulation secures fertilization.

Sexual Characters and Generative Organs of Microstomida.*—Herr D. Rywosch has examined *Microstoma lineare* and finds that it is not thoroughly bisexual, and indeed he is inclined to regard it as a completely hermaphrodite form; solitary males were never observed; in the anterior individual of a chain male generative organs were never found. The generative organs do not appear to become completely matured till an individual leaves the chain. The generative organs are ventral in position, and the female in front of the male; the author differs from Vejdovsky in regarding the testes as always single and never double. The penis varies in form, having sometimes the appearance described by Schultze, and sometimes that described by Graff. The ovary is a club-shaped tube formed by a structureless membrane and a number of egg-cells, not divided by constrictions; the ova are always developed from the median cells, and as they grow the number of bounding cells increases; these are used as food for the egg. The ovary passes into a distinct efferent duct, which opens on the median ventral line; the duct is invested by small cubical cells which are strongly ciliated, and by tubular granular glands. The presence or absence of sexual forms in autumn, as to which Schultze and Graff are in disagreement, appears to depend on climatic conditions.

Anatomy of Schizonemertini.†—M. R. Saint-Loup gives an account of the cephalic pits of *Cerebratulus viridis*, and *Ophiocephalus Elizabethæ;* he describes in the former a pillar which traverses the central mass; in it there are a longitudinal and two lateral canals which are so disposed that the cavity which contains the substance impregnated by hæmoglobin communicates with the exterior by the lateral ducts as well as by the cephalic pits; all the canals, with the exception of one which leads to the pharynx, are ciliated. In *Ophiocephalus Elizabethæ* the communications between the "pericerebral cavity" and the exterior are similarly arranged, but there does not seem to be any duct leading into the pharynx; the ducts end in the hæmoglobinoid substance, and are there enveloped with strongly coloured brownish-yellow granulations; so that an excretory glandular formation appears in the tissue to which respiratory functions are ascribed. In neither of these two forms does the author find the hepatic tissue noticed by M. Marion in *Borlasia Kefersteinii*, nor the uric acid concretions which have been observed in *Tetrastemma flavidum;* there are, however, granulations of a dark brown colour abundantly developed in some parts of the digestive tract. It seems, therefore, that Nemertines differ as to the localization of elements

* Zool. Anzeig., x. (1887) pp. 66-9. † Comptes Rendus, civ. (1887) pp. 237-9.

which have the same chemical function in the economy. The author has noted similar facts in the Hirudinea, and has shown the relation borne by the so-called hepatic tissue to the pigmented dermal ones. It is interesting to prove, in animals where the circulatory apparatus does not contain blood-corpuscles, that there is a migration of the corpuscles which seem to have a chemical action in the phenomena of assimilation, respiration, and excretion.

δ. Incertæ Sedis.

Rotifera.*—In Prof. A. G. Bourne's general essay on the Rotifera, the most interesting point noticed is, perhaps, the relations of the trochal disc. He accepts the view that the anus of veliger forms always forms so as to leave the primitive ciliated ring ("architroch") post-oral; that this architroch changes its position on the development of a prostomium, and that the two lateral portions come to lie longitudinally. These may be supposed to have coalesced so as to leave two rings—the one præoral, cephalotroch, and the other post-oral, branchiotroch. Among Rotifers the simplest condition is seen in *Microcodon*, where there is a single circumoral ring; if this be thrown into folds we get the conditions which obtain in *Stephanoceros*; further stages of complication through *Philodina*, *Lacinularia*, *Melicerta*, where both cephalotroch and branchiotroch are thrown into folds, lead to *Brachionus* where the cephalotroch becomes first convoluted, and then discontinuous. With regard to their power of resisting desiccation, Prof. Bourne expresses himself thus: "Many Rotifers exhibit an extraordinary power of resisting drought. Various observers have dried certain species upon the slide, kept them dry for a certain length of time, and then watched them come to life very shortly after the addition of a drop of water. The animal draws itself together so that the cuticle completely protects all the softer parts and prevents the animal itself from being thoroughly dried. This process is not without parallel in the higher groups." The Rotifera must be kept apart from the Mollusca, Arthropoda, and Chætopoda in our systematic classifications.

Key to the Rotifera.†—Dr. T. S. Stevens has prepared a key to facilitate the use of Hudson's and Gosse's Monograph on the Rotifera, and including only the genera and species described in that work. The intention is no doubt good, but the result is not satisfactory. It may possibly be of use to beginners, but no one but a beginner would be likely to make use of it; for it is perilously artificial, resting sometimes on a few comparatively unimportant characteristics. There are, too, obvious mistakes. *Apsilus* is said to be a free-swimming or floating genus, whereas it is a fixed one. *Floscularia* is set down as both a free-swimming genus and a fixed one; and though this may be defended because the genus has one free-swimmer, or rather one bad adherer, yet it would be puzzling to a beginner using the key. Again, *Limnias* and *Melicerta* are placed in the same group with *Floscularia* and *Stephanoceros*, in spite of the wide diversity in the position of the buccal orifice with respect to the body's longitudinal axis, thus showing how artificial the plan of the key is. The real difference in structure between *Callidina* and *Adineta*, that of the corona, is entirely missed, and the two genera (in the key) are made practically identical.

* Ency. Brit., xxi. (1886) pp. 4–8.
† Journ. Trenton (N.J.) Nat. Hist. Soc., 1887, pp. 26–43.

Echinodermata.

So-called Heart of Echinoderms.*—Professor E. Perrier, referring to the recent essays by M. Prouho, who disagrees with his results, and by M. Cuénot, who agrees with what he has taught as to the so-called heart or plastidogenous body of Echinoderms, resumes the history of our knowledge of this organ. He thinks that M. Prouho's results are not so essentially different from his as that author seems to suppose. He suggests the term *organe plastidogène* for the ovoid gland, as it is an organ which produces anatomical elements; he cannot believe that it has an excretory canal by means of which it is put into relation with the exterior, and he is inclined to agree with M. Kœhler's interpretation of the body as an appendage of the so-called vascular apparatus.

Organization of Echinoidea.†—M. H. Prouho, referring to some disputed points in the anatomy of sea-urchins, describes the water-vascular system; in *Dorocidaris* he finds an aquiferous system which communicates with the exterior by means of the madreporite, and which is formed of canals invested by a vibratile endothelium; there is also a "système vasculaire sanguin," or blood-vascular system, for which the author prefers the name of "système visceral vasculo-lacunaire"; this is in great part formed not of vessels, but of lacunæ hollowed out in the mesentery and its appendages; the internal marginal vessel is only a vast interstitial lacuna; at the level of their œsophageal rings these systems are closely applied to one another, but do not communicate; an exchange of currents between the two is impossible. The only changes that can be effected are such as are of an osmotic nature; a true diapædesis probably occurs. The visceral vasculo-lacunar system has no communication of any kind with the exterior. The canal which Professor Perrier calls the excretory canal of the ovoid gland is not a dependence of this system, but is an appendage of the aquiferous apparatus which allows the water that enters by the madreporite to come into contact with the walls of this gland. No exchange can be effected between this canal and the contents of the visceral plexus distributed to the walls of the ovoid organ, for it is opposed by a continuous epithelium. The term excretory canal appears to have led to a misunderstanding, and may therefore be well replaced by "annexed aquiferous duct." The contents of the aquiferous system are moved by the vibration of the endothelium of its vessels; while those of the vasculo-lacunar system can only move by a *vis a tergo* due to the repletion of the intestinal absorbents.

The two systems of canals and lacunæ aid in forming the perivisceral fluid which not only circulates actively around the viscera, but is also found in the cavity which is absolutely shut off from the visceral, and which contains the "lantern of Aristotle." The branchial appendages of the Cidarids are, as is now well known, internal and not external, and float in the general cavity. The author regards them as organs charged with the function of keeping an equilibrium between the liquid of the lantern and the perivisceral fluid which is outside it; this equilibrium is not one of pressure but of osmotic action.

Movements of Star-fishes.‡—Prof. W. Preyer's subsidiary title to this memoir will probably be a little astonishing to those who look on Echinoderms as some of the "lower Invertebrates"—it is "a comparative physiological-psychological investigation." The author was led to under-

* Comptes Rendus, civ. (1887) pp. 180–2.
† Ibid., pp. 706–8.
‡ MT. Zool. Stat. Neapel, vii. (1886) pp. 27–127 (27 figs.).

take the study of Echinoderms by the reflections raised by the observation of the physiology of the embryos of higher animals, many movements of which appear to be long inherited. After enumerating the twenty-one species on which he experimented, he speaks shortly of the work of previous observers, and expresses, *à propos* of the papers of Messrs. Romanes and Ewart, the very reasonable desire that physiological works should state definitely the species on which experiments were performed.

The ambulacral pedicles of Asterids are polydynamous organs of a special character; their mobility and sensitiveness, their large number, suctorial function, together with their locomotor and respiratory significance cause them to be of great interest. It was especially interesting to investigate the causes of the retraction and erection of these organs, which are capable of all kinds of vermiform movements and twistings; so long as the animal is quite fresh and normal, extension is more rapidly effected than retraction. The fundamental phenomenon is that which was long since mentioned by Tiedemann—the retraction of the suckers on slight mechanical irritation; dorsal irritation of a ray is almost but not quite as speedily followed by retraction of the suckers underlying the region touched; the extent of irradiation, or distance to which the stimulus exerted its effect, was found to vary with different species, but it was generally found that, in all five-rayed star-fishes, there was an almost simultaneous retraction of the central feet of the two neighbouring rays, and in very many cases of the remaining two later on. Chemical stimuli have a generally similar effect to mechanical stimuli.

Isolated rays were next examined and confirmed Romanes' observations; but differences were observed with different species, *Luidia* not responding as well as *Asterias*, and indicating that in it peripheral reflex actions were not so much independent of the central organ as in the less mobile and otherwise less sensitive species of *Asterias* and *Astropecten;* in the latter the radial medulla (an ambulacral spinal cord in the physiological sense) is more autonomous or less dependent on the ambulacral brain, or central nerve-ring with its rich supply of ganglionic cells.

With regard to the extension or erection of the suckers, it was found that strong centrodorsal mechanical irritation extended centrifugally into all the rays, but when it is weak the effects may be confined to the circumoral feet, and be transitory. The extension of the suckers after local dorsal stimulation is always a central process; if the centres are wanting or injured, and their connections broken, the extension is affected. The details of experiments with electrical and thermal stimuli are also given.

It is clear from these experiments that—

(1) If, on an uninjured star-fish, a local ventral or dorsal stimulation exerts only a local effect there is always a retraction, and never an extension of the ambulacral feet.

(2) If a local dorsal stimulus irradiates, a general extension from the centrum follows, and never a retraction; thus:—

Place of stimulation.	Result.
Dorsal.	Local: Retraction.
Excentric or "dorsal"	Irradial: Extension.
Ventral.	Local: Retraction.
Excentric or central	Irradial: Retraction. / Extension.

After describing the phenomena of attachment to foreign bodies, of creeping, and of climbing, the author enters upon an interesting account

of the way in which star-fishes and brittle-stars right themselves, or return to their normal position; the description given by Mr. Romanes and Prof. Ewart is, generally, exact, but the exact method of righting is not the same in all the species of star-fishes, though brittle-stars much more closely resemble one another. The experiments were varied by the application of drugs, differences of temperature, and weights. The result of all is the definite conviction that the movement is not due to any external peripheral reflex stimulation. The impulse which comes to the central organ, or (in Asterids) to the subordinate centres of the radial medulla of separate pieces of the rays must, it may be thought, be either central or centripetal; against the former supposition, which would be explained by imagining that the abnormal position had caused a disturbance of the circulation, Prof. Preyer cites certain experiments on frogs; and the same objection may be raised to the second suggestion. What explains the righting of frogs—namely the "muscular or innervation sense"—may be applied also to Echinoderms.

The memoir concludes with some observations on movements away from an object, such as an attempt by an Ophiurid to get away from or free itself of a tube drawn over one of its arms; the author describes the five different ways in which the brittle-star acted; when the tube was loose, it tried to rub it off by drawing along the floor of the aquarium; when the tube was rather tighter it tried to shake it off, or held it down with the neighbouring arms and tried to draw the median arm out, or it tried to push it off with the two neighbouring arms, or it broke off the arm that was covered by the tube. It is impossible to refer such phenomena as these to simple reflex action; the Ophiurids rather possess the power to adapt themselves to quite new situations, such as they have not experienced before. If intelligence depends on the power of making experiments, that is of learning, and making use of what is learnt in a new way, then Ophiurids must be very intelligent. Complicated movements of a like kind were never seen in Asterids.

Homologies of Larvæ of Comatulidæ.*—M. J. Barrois thinks that the facts that the closure of the blastopore of the larva is effected not far from the spot at which the opening of the calyx appears later on, and that the ventral pit corresponds in situation to the buccal invagination of the other larvæ of Echinoderms, should show us that we ought not to consider the region of the calyx as anterior and that of the peduncle as posterior, but *vice versâ*; the pentacrinoid, then, cannot be considered as arising from a larva fixed by its posterior part, but as one fixed by its preoral lobe.

Researches on the metamorphoses of Echini have led the author to conclude that the larva ought to be considered as being composed of two parts, an anterior formed by the portion which projects above the subumbrella, that is, the preoral lobe and the œsophageal region, and of a posterior part composed of the rest of the body; during metamorphosis the former is detached at its base, and the latter is transformed into the urchin. These two parts correspond to the two fundamental divisions (calyx and peduncle) of the larvæ of Comatulids.

Cœlenterata.

Natural History of Hydra.†—Continuing his studies on the divisibility of living matter Herr M. Nussbaum has devoted his attention to the genus *Hydra*, of which he gives a monographic account.

* Comptes Rendus, ciii. (1887) pp. 892–3.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 265–366 (8 pls.).

He distinguishes four species, noting the diagnoses and synonyms, viz. *Hydra viridis*, *H. grisea*, *H. fusca*, and less certainly *H. attenuata* of a pale straw-yellow colour. A careful and detailed account is then given of the histology of this organism which has been the subject of so many investigations. From the nature of the case the results are rather corroboratory than novel.

The second part of the memoir is devoted to a description of the author's numerous experiments on the familiar power of regeneration and wound-healing exhibited by mutilated polyps. Slices were cut out of the body in any direction, and divided into four or so portions, which regenerated new organisms. As has been previously noticed, the experiments of Trembley as to the survival of *Hydra* after being turned inside out are confirmed, while it is further shown that there is no modification of ectoderm into endoderm, and endoderm into ectoderm, but that new growths restore the old layers. An ectoderm grows over the exterior, and the elements, no longer able to continue in their reversed conditions, are absorbed and replaced by fresh cells. The concluding chapter of Nussbaum's paper is an interesting historical sketch.

Nematocysts of Hydra fusca.*—Mr. R. J. Harvey Gibson, by the use of eosin and some specially large *Hydræ*, has been able to make out distinctly the anatomy of the resting stage of nematocysts; the wall is firm, transparent, and more or less elastic; it is occasionally surrounded by a clear crescentic space, which intervenes between the capsule and the protoplasm of the ectoderm-cell; at the narrower end of the capsule a distinct depression can, under a high power (Zeiss 1/12 in. oil-immersion), be made out; on one side of this rim there is an appearance of discontinuity in the substance of the capsule. In the interior of the capsule there is a funnel-shaped membranous tube which at about one-third of the length of the capsule becomes enveloped in a general mass which occupies the rest of the space. Mr. Gibson calls this tube the "pharynx." When a living *Hydra* is "irrigated" with dilute acetic acid, the pharynx and an enormously long thread are everted: to investigate the stages of eversion a living tentacle was stimulated with acetic acid, and this was immediately followed by the application of a small drop of one-quarter per cent. osmic acid. Most of the nematocysts were arrested in the act of exploding; some had only the pharynx evaginated; some, in addition, had a thread about four times the length of the capsule protruding, and that thread was double the usual thickness of the entirely everted thread; in those in which the evagination of the thread had been arrested in its last stage there was a long club-shaped extremity; in most of these and also in the partially everted threads, careful focusing revealed another thread distinguished by its faint spiral twist. The author is of opinion that, though the forces which bring about the evagination of a nematocyst may be physical, they are under the command of the *Hydra;* the initial act in the process is the dissolution of continuity between the lid and the capsule.

The development of the nematocyst commences with a granular differentiation of the protoplasm in any part of the cell; the granule grows and becomes a circular sac; at one point an invagination is made, and the coiled finger-like process grows and coils round and round the central tube; the capsule broadens and the central pharynx developes the arrow-head spikes of the adult nematocyst.

Living parasitically was a species of *Euplotes* which wanders freely all over the *Hydra;* they were found to contain many nematocysts, both large

* Proc. Lit. and Philos. Soc. Liverpool, xxxix. (1885) pp. 29–38 (1 pl.).

and small, which had obviously been swallowed. It is not understood why the *Hydra* does not discharge nematocysts at them, or why the cysts themselves do not explode in the interior of the parasite.

Stinging Cells.*—M. M. Bedot has studied the structure and development of the stinging-cells in Velellidæ and Physalidæ. He notes the importance of confining the term cnidoblast to the cell which gives rise to the nematocyst or homogeneous capsule inclosing the filament. In Velellidæ four kinds of cnidoblasts are described—small and large, either with or without stalk. The large cnidoblasts inclose large oval nematocysts with a handle, and the filament rolled very regularly within the capsule, while the small nematocysts in the small cnidoblasts are more elongated, have no handle, and the filament irregularly disposed. In Physalidæ two kinds are distinguished, differing in length of stalk and size of nematocyst.

After noting the various modes of distribution and arrangement, the author proceeds to give an account of their development. Before the stinging-pad is formed, a section of a tentacle exhibits among the ectoderm cells certain cnidoblasts with nematocysts in process of formation. The ectoderm thickens at two opposite points. The developing cnidoblasts come to the surface, but remain attached to the supporting mesoderm layer. The lengthening of the stalks of the cnidoblasts is not the cause, but the effect of the formation of the pad. The formation of the gelatinous tissue of the tentacles is also described. To follow the development of the nematocysts, a piece of the central organ should be separated. The first trace of the appearance of the nematocyst in the simple cnidoblast is the formation of a vacuole which grows in the protoplasm. From the margin of the vacuole a little bud grows into the transparent contents. This is the nematoblast which gives rise to the stinging filament. In Physalids this rudiment increases as a pear-shaped bud, a canal appears in the stalk and extends into the swollen portion, the protoplasm condenses round the canal and forms a wall. The envelope of the nematocyst is formed by the transparent substance which fills the primitive vacuole. In both Physalids and Velellids two nematocysts may be formed within a cnidoblast. In Velellids the development is complicated by the presence of the handle of the filament. The nematoblast appears as a minute sphere. Opposite the stalk a prolongation grows out, representing the filament. The sphere itself forms the first portion of the handle, while a second spherule near the filament forms the other portion of the handle and hooks.

New Rhizostomatous Medusa.†—Mr. J. W. Fewkes describes a new medusa, the only non-tentaculated member of the group known, as yet, on the Atlantic coast of North America, and he gives it the name *Nectopilema Verrilli*.

Owing to the damaged condition in which it was found, only an imperfect description is possible; and only the margin of the umbella and oral arms are touched upon.

The new genus belongs to Häckel's family Pilemidæ, and probably to the sub-family Eupilemidæ. Its nearest allies appear to be *Pilema* and *Rhopilema;* and it serves to connect the sub-families Eupilemidæ and Stomolophidæ.

New genus of Stylasteridæ.‡—Mr. R. Kirkpatrick describes a new Stylasterid from Mauritius, for which he proposes the name of *Phalangopora regularis* g. et sp. n.; it is allied to *Errina*, but differs in having the gastro-

* Rec. Zool. Suisse, iv. (1886) pp. 51–70 (2 pls.).
† Amer. Journ. Sci., xxxiii. (1887) pp. 119–25 (1 pl.).
‡ Ann. and Mag. Nat. Hist., xix. (1887) pp. 212–4 (1 pl.).

pores in single linear series; the separation of the gastropore and dactylopore systems is a further distinctive feature.

Coral Studies.*—Dr. A. R. v. Heider is led by the study of *Astroides calycularis* and *Dendrophyllia ramea* to some general considerations as to the structure of corals. He is firmly convinced of the presence in intact living corals of an outer soft investment to the theca; in colonial forms the body-walls of the polyp very soon pass into the cœnosarc which connects the separate individuals, and then the investing part becomes very hard to detect. In the solitary form it is otherwise, and in *Dendrophyllia*, for example, the outer investment is often considerably longer than the polyp. This outer thecal covering or marginal plate, has not the same composition in all corals; in *Cladocera*, *Dendrophyllia*, &c., all the three layers are present; but in *Astroides* and *Flabellum* (according to Prof. Moseley) the outer surface of the skeleton is formed directly of a simple layer of meso- and ectoderm, and there is no continuation of the body-cavity between the theca and the body-wall.

It is, morphologically, a very important fact that in one group of corals which, according to present systematic arrangements, consists of members of various families, the theca is formed quite independently of the body-wall, and that in another group the body-wall takes up the theca into its mesodermal layer. If this generalization be correct we have two divisions of Madreporaria: that of the Euthecalia in which the body-wall secretes calcareous substances within its mesodermal lamella, and forms an "eutheca" which ultimately becomes connected with the septa; and that of the Pseudothecalia, in which the body remains connected with its three layers and secretes no theca, but in which the septa become connected by calcareous substance at their peripheral ends, and so form a "pseudotheca," outside which is the continuation of the body-cavity. In skeletons deprived of their soft parts it is, of course, difficult, or even impossible, to determine how the theca has been formed; the author is inclined to think that well-developed costæ are associated with a pseudotheca.

It would appear that the ectodermal layer of the young polyp which excretes the calcareous matter is completely surrounded in time by the mesoderm; the author does not agree with Dr. von Koch in thinking that the cells persist and excrete lime, but that they are converted into it, and that, therefore, they cease to exist as cells.

Anatomy of Fungia.†—Mr. G. C. Bourne describes the arrangement of the tentacles and septa, which is very regular in *Fungia*, and not irregular, as has previously been supposed. Prof. Duncan's doubt whether there were any mesenteries is shown to be unfounded, and indeed, they have all the essential characters of the mesenteries typical of Hexactinian Actiniaria; seven orders correspond to the seven orders of septa. There are no synapticulæ in the upper portions of the interseptal loculi, where the mesenteries are free to radiate across the whole space between the mouth and the periphery of the disc; here then is the ordinary central structureless supporting lamina which the author proposes to call the mesoglœa—this new term being the equivalent of the German "Gallertlage"—of which the bodies of Medusæ are for the most part made up.

The cœlenteron is represented by the axial space lying below the stomodæum, the peripheral chambers known as exocœles and endocœles, and the space which lies between the theca and the outer body-wall; the complicated relations of their parts only seem to be explicable on the theory of

* Zeitschr. f. Wiss. Zool., xliv. (1886) pp. 507–35 (2 pls.).
† Quart. Journ. Micr. Sci., xxvii. (1887) pp. 293–324 (3 pls.).

von Koch, that the corallum is derived primitively from the basal ectoderm, and that the theca is formed by the fused peripheral parts of the septa, which in fusing divide the mesenteries, and leave a portion of the cœlenteron external to the theca. During life the animal constantly closes the middle portion of its mouth, apertures being left at either end by which water passes in and out.

The histological characters of *Fungia* are simple and conform to the Actinian type. Dealing specially with the mesoglœa of the Cœlenterata, the new name appears to be justifiable on the ground that the tissue does not seem to be homologous with the mesoblast of the Triploblastic Metazoa; in the Hydromedusæ it is a fine, apparently structureless membrane placed between endoderm and ectoderm; in the Siphonophora it is a structureless jelly-like substance; in the Scyphomedusæ it is structureless, but has a fibrillar arrangement; in the Discomedusæ (Aurelia) it contains a number of oval or stellate cells, and in the Ctenophora there are muscular stellate cells. In the Alcyonaria, cells lie imbedded in a gelatinous matrix and in them the calcareous spicules of the skeleton are developed; in the Actiniaria Madreporaria the lamina is fibrillar and contains a few connective-tissue cells. Various arguments against its complete homology with the mesoblast are advanced by the author.

Arrangement of the Mesenteries in the parasitic larva of Halcampa chrysanthellum (Peach).*—Prof. A. C. Haddon gives a bibliography of all the Actiniæ known to occur as parasites on Medusæ. It appears that *Halcampa fultoni* is the larva of *H. chrysanthellum* (N. Europe); *Philomedusa vogtii* and *H. medusophila* are probably the young of *Halcampella endromitata* (Mediterranean); *Bicidium parasiticum* is a *Peachia* (N.E. America); lastly there are *Halcampa clavus* (Southern Ocean) and a parasitic larval *Edwardsia* (N.E. America). A description of the larva of *H. chrysanthellum* is given. Only eight tentacles are present. In the œsophageal region the twelve mesenteries appear to have equal importance. A deep siphonoglyphe is present which extends for a short distance below the œsophagus. In the gastric region there are eight large mesenteries which alone bear the enlarged digestive borders; the other four mesenteries are shorter and have smaller muscular bands than the former. Those four intra-mesenterial chambers, which are bounded by a strong and a weak mesentery, are alone not prolonged into a tentacle. The dorsal directive mesenteries also appear somewhat smaller than the remaining six strong mesenteries. From the position of the muscular band it is evident that the eight strong mesenteries of the larval *Halcampa* are homologous with the eight mesenteries of *Edwardsia* and not with the eight strong mesenteries of other larval Actiniæ. It is interesting to note that no siphonoglyphe is noticeable in the adult, though it is very conspicuous in the larva; and also that in the adult only six (lateral and ventral) mesenteries bear generative organs; these correspond to the above-mentioned larval mesenteries. For the present we may assert that, although the adult *Halcampa* closely resembles the ordinary Actiniæ in the ratio of its tentacles and the disposition of its mesenteries, the larval form is undoubtedly more nearly allied to the *Edwardsiæ*.

Porifera.

Synocils, Sensory Organs of Sponges.†—Dr. R. v. Lendenfeld refers to a remark made in this Journal on the occasion of our reporting his account

* Proc. R. Dublin Soc., v. (1887) pp. 473–81 (1 pl.).
† Zool. Anzeig., x. (1887) pp. 142–5.

of a discovery of a nervous system in sponges; we drew attention to his apparent ignorance of a demonstration made at a meeting of the Society by Prof. C. Stewart. Prof. Stewart's discovery was published, with an illustrative figure, on p. 431 of Prof. Bell's 'Comparative Anatomy and Physiology'* (1885). This figure showed Dr. v. Lendenfeld that Stewart's sensory cells were different from those described by himself, and by the kindness of the latter he has been enabled to examine the original specimens.

He describes very long and large conical processes as arising everywhere on the surface of the sponge, and as having a widened basal piece; they are almost 0·1 mm. long, and about 0·016 mm. broad at their base; they are especially numerous at the entrance to the interradial currents. As neither F. E. Schulze nor Häckel have observed these structures in living Sycandræ, and as Dr. v. Lendenfeld has never seen them, he suggests that they are ordinarily retracted, and are only to be found extended under specially favourable conditions.

The processes consist of a substance which is identical with mesodermal intercellular substance, and are, apparently, invested by tubular epithelium; just below the broadened base there are several oval nuclei, surrounded by somewhat irregular plasmatic investments, and continued as a fine filament to the tip of the conical "palpocil"; Stewart's figure shows only one cell in each palpocil. If the process be withdrawn we get a group of cells very similar to the pyriform sensory cells already figured by von Lendenfeld.

The author concludes that in certain sponges there are special sensory organs which cannot be compared with what are found in Cœlenterates or Cœlomata; they may be called synocils in opposition to the simple palpocils. They probably represent a higher grade of development of the ordinary palpocil with its proper sensory cell, and perhaps owe their origin to the fusion of several simple palpocils, and the surrounding of the group with a proportionately well-developed layer of mesodermal intercellular substance; they are of mesodermal and not endodermal origin. The pyriform cells, which unite to form the synocil, are homologous and analogous with the spindle-shaped sensory cells of other sponges.

Position of the Ampullaceous Sac and Function of the Water-canal-system in Spongida.†—Mr. H. J. Carter endeavours to show that the pores in a sponge are as much for the general circulation and respiratory function as for the introduction of nutriment, and that the ampullaceous sac [or flagellated chamber], being situated on the surface of the excretory canals, only requires a single aperture to fulfil its function. He finds new evidence to support this view in a new species of South Australian sponge, which he calls *Wilsonella echinonematissima*. At the same time he does not doubt that in many instances there is more than one aperture in the sacs, but states that there is probably an equal number in which there is only one that serves the two purposes of inception of nutrient particles and exit of unassimilated material. The new species of sponge is remarkable as having the body-fibre of the Echinonematous type, and the terminal part that of a Psammonematous sponge; the sacs are sharply defined, persistent, comparatively scanty, and unusually tough under manipulation, so as to render the species excellent for observations on these structures.

* Which Dr. v. Lendenfeld quotes as 'Bell's Text-book of Zoology,' London, 1886, p. 144.

† Ann. and Mag. Nat. Hist., xix. (1887) pp. 203–12.

Observations on Fresh-water Sponges.*—Dr. A. Wierzejski has some various notes on fresh-water sponges. He thinks that Herr Noll is wrong in his account of the development of gemmulæ-balls of *Spongia fragilis*; they do not develope from extraordinarily large rudiments by division within the cellular cortical layer, but from special rudiments which the author has already described.

With reference to Dr. Vejdovsky's limitation of the hitherto known Spongillidæ to eight species, pleas are put forward against *Euspongilla rhenana* Retzer, and in favour of *Ephydatia mülleri* for which he thinks a special place ought to be found.

Protozoa.

Reticulated Structure of Protozoa.†—M. J. Kunstler calls attention to a communication of his in 1881 in which he describes the structure of protoplasm as alveolar. Without excluding strictly reticulated structure, numerous observations go to show that vacuolar or alveolar is in many cases the more accurate description. He notes the various modifications of these alveoli.

In *Dumontia apheliarum* the vacuolar elements are aggregated in a continuous mass, and do not separate into secondary groups. The small peripheral alveoli which are not disposed in very regular layers, enlarge towards the interior, and form a network with polygonal meshes. An areolar structure of a similar character is seen in the internal protoplasm of some Gregarines. The vacuoles contain fine granules. The circulating food-vacuoles are then discussed. According to the author they are surrounded by a proteid layer, formed at the mouth, and constituting transitory but coherent stomachs. In the Cryptomonads these are replaced by a permanent cul-de-sac. Even the flagella exhibit an alveolar structure.

Reticular Structure of Protoplasm of Infusoria.‡ — M. Fabre-Domergue recommends the following method of demonstrating the fine reticulation of the protoplasm of *Paramæcium*, *Vorticella*, and other infusorians. They are fixed by a weak solution of iodine, washed with 10 per cent. solution of potash, and then with distilled water; a drop of very dilute acetic acid is afterwards added. After coloration with eosin the protoplasmic trabeculæ are seen with the greatest distinctness. They are very loose at the centre of the body, but more close in the ectosarc, where, as in *Opalina*, *Paramæcium* is vacuolated. The viscosity of the protoplasm is shown to be in relation to the condensation of the reticulum. This last represents the fixed part of the protoplasm, and it is by the differentiation of its substance at a given point that the contractile vesicle is formed. The passage of food along a straight line in *Didinium nasutum* is likewise due to the physiological differentiation of this reticulum. A distinction must be made between infusorians in which there is a structural peripheral reticulum and those which possess in addition an isolable cuticular membrane. This latter must not be confounded under the generic term of integument; the Oxytrichidæ, notwithstanding their cuirass-like ectoplasm, are really naked Infusoria.

Multiplication of Ciliated Infusorians.§—According to M. E. Maupas (*a*) the reproductive power of Ciliata depends on (1) the quality and quantity of food, (2) the temperature, and (3) the alimentary adaptation of

* Zool. Anzeig., x. (1887) pp. 122–6.
† Comptes Rendus, civ. (1887) pp. 1009–11.
‡ Ibid., pp. 797–9.
§ Ibid., pp. 1006–8.

the buccal organ. (*b*) Herbivorous, carnivorous, and omnivorous forms occur. *Cryptochilum*, *Paramæcium*, *Colpoda*, *Tillina*, *Colpidium*, and *Vorticella* feed on schizomycetes and small zoospores, thus purifying the water from Bacteria, Vibriones, Bacilli, and other microbes. *Stentor*, *Euplotes*, many *Oxytrichas* are omnivorous, while *Euchelys*, *Didinium*, *Lacrymaria*, *Leucophra*, *Trachelidæ*, and *Coleps* are carnivorous, though not despising zoogloœa. (*c*) The herbivorous population is followed by the carnivorous with approximate regularity. *Coleps hirtus* can in a few days clear off a dense population of herbivorous forms.

(*d*) M. Maupas has carefully studied the reproductive powers of *Stylonychia pustulata* throughout many generations. In favourable nutritive conditions this species divides once in 24 hours with a temperature of 7°–10° C., twice at 10°–15°, 3 at 15°–20°, 4 times at 20°–24°, and 5 times at 24°–27°. At a temperature of 25°–26° C. a single *Stylonychia* would in 4 days have a progeny of a million, in 6 days of a billion, in 7½ days of a hundred billion. In 6 days the race would weigh 1 kg., and in 7½ days 100 kg. (*e*) With a vegetarian diet, however, the rate of reproduction is much less, and the size smaller. (*f*) Light seemed to have no influence on the development. Statistics are given for a large number of forms.

Protozoa of Marseilles.*—MM. P. Gourret and P. Roeser give an account of the Protozoa found by them in the old port at Marseilles; of the fifty-eight species which they enumerate twenty are new, and there are also some new varieties; they divide the localities examined into twenty, and point out that, where the waters are almost normal in character, there are both few species and few individuals as compared with stations where the water is putrid; among the stations of putrid water it seems that the number of forms increases with the foulness of the water, though there are, of course, limitations to this.

(1) *The Holotrichous Infusoria.—Paramæcium pyriforme* is a new species, varying in size, pyriform in shape, and with the mouth placed at the bottom of a groove which passes obliquely from right to left; there is a pharyngeal swelling, infundibular in shape, and continued into a short narrow cylindrical tube, which opens freely into the endocyte or central protoplasm. It is not possible to distinguish the oral cilia from the ordinary cilia of the cuticle; trichocysts do not seem to be present. The anterior contractile vacuole appears to be, and the posterior not to be constant; micrococci may often be seen in the clear parenchyma. This new species seems to be most nearly allied to *P. chrysalis* var. *viridis*. *Placus striatus*, first found by Cohn near Breslau, and *Nassula flava* are next described; of the latter *Chilodon ornatus* and *N. aurea* appear to be synonyms. *Enchelyodon striatus* sp. n. is flask-shaped, with a short neck, and a slight anterior swelling at the top of which the mouth opens. It moves very slowly, but its neck is very mobile and extensile; the cuticle is marked by two sets of striæ, one longitudinal and one transverse; the covering cilia are very short, but around the mouth the cilia are longer and more vigorous; the contractile vesicle is irregular in form and very large; this species seems to be nearest to *E. elongatus*. A new variety of *Metacystis truncula* is described, and is called variety *crassa*. The next three forms noticed are *Trachelocerca phœnicopterus*, *Lacrymaria coronata*, and *Chœnia teres;* of *Amphileptus* there are two new species—*A. lacazei* and *A. massiliensis;* the former is provided with special long vibratile cilia, in addition to others arranged in tufts; these are separated from one another, and are ordinarily placed in the interspaces between the tufts; they appear to be specially useful in move-

* Arch. Zool. Expér. et Gén., iv. (1886) pp. 443–534 (8 pls.).

ment. Longer and more compactly arranged cilia are found in the region of the mouth, and seem to have their function limited to producing an alimentary current. *A. lacazei* seems to be most nearly allied to *A. margaritifer*, and to have some resemblance to *A. cygnus*. *A. massiliensis* varies in size, and moves not only by the aid of its cilia, but also by the successive contraction and dilatation of the whole mass; sometimes it may be seen to twist on itself. *Loxophyllum pyriforme* sp. n. has a great power of contraction, and is incessantly changing its form; the cilia do not appear to be regularly distributed, though the trichocysts, which are found all over the body, are so; the endoplast appears to consist of two oval nuclei, of some size, very granular, and without nucleoli. *Lembadion ovale*, another new species, differs from the only species of the genus yet definitely described by having only one caudal seta, by the elongated form of its buccal pit, the elongation of its vibratile membrane, and other characters. After an account of *Plagiopyla nasuta* var. *marina*, and *Cyclidium glaucoma*, *Lembus intermedius* is described; it is very agile and extensile, but, on the least pressure, divides into two, a little behind the mouth.

(2) *Heterotrichous Infusoria.—Metopus sigmoides* is recorded, and a long account is given of *Condylostoma patens*, as to which previous writers have been in some disagreement, and a revised synonymy of the species is offered.

(3) *Peritrichous Infusoria.—Mesodinium pulex*, and *Gyrocoris oxyura* are described, as well as *Vorticella nebulifera;* of this last genus there are also two new species: *V. plicata*, distinguished by its longitudinal folds, and *V. anomala* which is remarkable for the delicacy of its anterior end, and the elongate cylindrical form of its pharynx; the contractile vesicle is very large; the stalk differs from that of most members of the genus in being contractile in its anterior half only; this is made up of a fine unornamented cuticle, a hyaline peripheral zone, a thick contractile sarcolemma, and a slender central cylinder. The lower half of the stalk has the cuticle thicker; this new form is interesting as being intermediate between the Vorticellidæ with a contractile, and those with a rigid peduncle. It is very rare. Of *Zoothamnium* two species were found, of which *Z. alternans* was described by Claparède and Lachmann, and *Z. plicatum*, which is new, and is distinguished from *Z. marinum* by having the stalk jointed, and by the possession of longitudinal striæ on the cuticle. *Epistylis barbata* is a new and very common species; it is perfectly smooth externally, and has an elevated vibratile disc; it contains parasitic cysts of, apparently, an *Opalina;* this small infusorian introduces itself by the peristome, and passes into the parenchyma, living at the expense of its host which it completely destroys. When set free the cyst swims about rapidly and undergoes a number of modifications. *Cothurnia fusiformis* sp. n. is very closely allied to *C. nodosa; C. striata* sp. n. differs from *C. pusilla* by the size of the body, the presence of cuticular annellations, the absence of an operculum, and the shortness of the peduncle.

(4) *Hypotrichous Infusoria.—Chilodon complanatus* sp. n. is continually changing its form, and has a distinct ventral surface very different from the dorsal; the mouth is large, the pharynx short, conical, and provided with chitinous rods, which form a framework for it; it has no vibratile lip, as in *C. cucullulus*, in the company of which it is found living. *Ægyria angustata* with a variety, *ovalis*, is next described; *Æ. marioni* is a new species, and is marked by the reduction of the frontal and ventral cilia, the presence of a spiny crest on the left valve, the longitudinal striæ in the dorsal region, and the form of its swallowing apparatus. *Æ. monostyla*, *Æ. fluviatilis* (var. n. *marina*), *Aspidisca polystyla* (var. n. *maxima*) are next noticed;

Aspidisca bipartita is a new species remarkable for the absence of hook-like appendages, and the apparent conversion of the posterior stylets into cirri or cilia. *Glaucoma pyriformis* and *Euplotes Charon* are followed by the description of *E. gabrieli* sp. n.; this is distinguished from *E. longipes* by the presence of a frontal tooth, the length of the frontal cirri, and other characters, and from *E. harpa* by the absence of longitudinal striæ, the size of the posterior stylets and frontal cirri, and the form of its nucleus, which is a large spherical mass.

(5) *Flagellate Infusoria.—Cercomonas crassicauda, C. longicauda, Polytoma uvella, Oxyrrhis marina, Sphærophrya pusilla* (with which *S. sol, S. paramæciorum, S. urostylæ*, and *S. magna* are united) are next noticed; *S. massiliensis* is a new species in which it is interesting to study the phenomena of division; in it, and probably in other species of the genus, there is an external limiting membrane, which takes a share in the fission; this membrane is identical with that of the Acinetæ. After a short account of *Acineta fœtida, A. contorta* and *A. parroceli* complete the paper; these last are both new species, the former is large, and both it and *A. parroceli* somewhat recall *A. crenata;* they are both very remarkable in the fact that the orifice of the test, though wide, is very narrow in proportion to the dimensions; the arrangement of the tentacles in *A. contorta* is normal, but in *A. parroceli* these appendages are more like those of *Podophrya elongata* where they are ranged along the body; they are very fine, short, and comparatively numerous. *A. contorta* feeds on *Euplotes.*

New Protozoa.*—Mr. W. Milne describes and figures a new form, belonging to the Tentaculifera, to which he gives the name *Stylostoma Forrestii* nov. gen. et sp. It is marine, and was attached to a *Cyclops.* The new genus is founded on the fact that the capitate tentacles do not spring directly from the body, but arise in groups at the extremities of three arms. Vermiform zooids are described, but were not traced to the adult form.

A new species of *Strombidinopsis* is described, to which the specific name *proboscidifer* is given. The truncate end carries numerous "tentacle-like cilia, finely feathered with minute cilia all round their whole length." Inside this ring is a membranous collar, and within this is a protrusible proboscis. The author compares the ring of cilia to the membrane of *Torquatella,* and shows how it could be derived from the latter. A peculiar method of reproduction is noted. A new species of *Oxytricha* is described as *O. tricornis.* Both these forms are marine. Some observations are made on *Ophridium sessile* S. Kent and *Amphisia multiseta* Sterki, and of the latter certain doubtful stages in development are described.

New Fresh-water Infusoria.†—Dr. A. C. Stokes gives definitions of a number of new genera and species of fresh-water infusorians. *Trentonia* (*T. flagellata* sp. n.) is allied to *Raphidomonas;* one flagellum is trailing and one vibratile, and the frontal border is slightly bilabiate; no trichocysts were observed; the trailing flagellum is best seen when the creature is rendered uncomfortable and sluggish by prolonged confinement beneath the cover, or partially poisoned by iodine; the author suggests that *Raphidomonas semen* may have two flagella; if not, *T. flagellata* will form the type of a new family of *Trentoni*[*i*]*dæ. Cyclonexis* is a new genus which differs from *Uvella* in the lateral instead of the posterior union of the constituent animalcules, in the annular rather than spheroidal form of the colony, and in the very diverse length of the two flagella. *C. annularis* sp. n. was found with *Sphagnum.*

* Proc. Phil. Soc. Glasgow, 1886, 8 pp. (1 pl.).
† Proc. Amer. Phil. Soc., 1886, pp. 562–8 (1 pl.).

Opisthostyla is a new genus, the constituents of the colonies of which resemble those of *Rhabdostyla*, "but the rigid pedicel curved near its point of attachment to the submerged object, this part acting when the zooid is contracted like a spring, and throwing the animalcule and the otherwise inflexible footstalk backward through the water, the whole immediately becoming upright by the recoil of the curved extremity of the pedicel." *O. annulata* is a new species, and *Rhabdostyla pusilla*, described by the author in 1886, clearly belongs to this genus. *Acinetactis mirabilis* g. et sp. n. differs from *Actinomonas* by having two flagella, and by the distinctly capitate character of the filamentous pseudopodia, which are often conspicuously pin-like in appearance. The flagellum may be temporarily adherent, and its pressure in addition to the habitually vibratile appendage necessitates the formation of a new family which may be called Acinetactidæ.

The other new species described are *Mastigamœba longifilum*, *Anisonema pusilla*, *Cryptoglena truncata*, *Pyxidium urceolatum*, *Rhabdostyla invaginata*, in which the ciliary disc has a characteristic conical form, *Colpoda depressa*, in which the oral aperture is on the flattened ventral surface, *Metopides acuminata*, *Trichophrya sinuosa*, which is much smaller than *T. epistylidis*, *Acineta lacustris*, which was found attached to *Anacharis*, and *A. stagnatilis*, which was found on *Myriophyllum*.

New Hypotrichous Infusoria.*—Dr. A. C. Stokes describes a new genus of Hypotrichous Infusoria, for which he proposes the name of *Hemicycliostyla;* the forms are free-swimming, have twenty or more frontal styles, arranged in two more or less semicircular rows, no anal styles, contractile vesicles single or double, nucleus multiple; *H. sphagni* sp. n. is 1/50 to 1/60 in. long, one-fourth as broad, anal aperture dorsal, parenchyma vacuolar, adoral cilia short. An allied form is distinguished by having only one contractile vesicle, the absence of vacuolar spaces, and the development of a conspicuous series of par-oral cilia on the inner edge of the left-hand border of the peristome field; it may be called *H. trichota* sp. n.

Urostyla gigas is a giant among Infusoria, having, when extended, the length of 1/30 in.; like the preceding species, it was found with *Sphagnum*. There are from forty to sixty nuclei, which, if they have a connecting thread, must have a very frail one, as the nuclear nodules float out freely and separately from the disintegrated dead body. *U. caudata* sp. n. is an ally. Three new species of *Holosticha*—*H. caudata*, *H. hymenophora*, and *H. similis*—are described; as yet only one fresh-water species has been recorded. The new form will require an emendation of the generic definition, as the peristomial membrane, the increased number of frontal styles (five in *H. hymenophora* and about fourteen in *H. similis*), and the double contractile vesicle of the former, have not yet been noticed; *H. similis* is alone known to have a moniliform vesicle. In *Uroleptus dispar* sp. n. the difference in the size of the ventral setæ of the two median rows is unusually well marked; there is in it that prolongation of the anterior end as a narrow crescent which is often seen in Infusoria, and which is usually styled the upper lip; Dr. Stokes believes that it is a continuation of the ventral plane, and that it ought therefore to be called the lower lip. *U. longicaudatus* sp. n., also found with *Sphagnum*, is unusually active, and is very flexible and elastic.

Eschaneustyla g. n. most nearly approaches *Urostyla;* it has the ventral setæ in three unequal longitudinal lines; it is remarkable for having a spherical pulsating vacuole, with canal-like diverticula, somewhat resem-

* Proc. Amer. Phil. Soc., 1886, pp. 21–30 (1 pl.).

bling that of *Stentor*; *E. brachytona* is the new species. *Platytrichotus* is a new genus (*P. opisthobolus* sp. n.) which appears to connect *Holosticha* and *Uroleptus*; its caudal appendage is not constant, but changeable in form and extent; in addition to the immobile dorsal hairs there are three long flattened setæ, which are voluntarily vibratile.

Leucophrys patula.* — M. E. Maupas offers some remarks on the strictures lately made by M. Balbiani † on his account of the development of this infusorian. He states that he was well acquainted with the results of previous observers, and he gives what he thinks is a complete list of Ciliata which multiply after encystation in the way described by him. What was seen in *Leucophrys* was, however, essentially different; there is in their history no encystation—what happens is this, so long as there is abundance of food, fission obtains; when food grows scanty there is metamorphosis without encystation, followed by six successive divisions. While this is the morphological difference, the physiological one is no less important—the divisions are effected without vegetative growth, and have for their final object not multiplication but conjugation. With regard to the fecundity of the *Ichthyophthirius* cited by M. Balbiani the author accepts the number of a thousand individuals in three days, but he points out that *Leucophrys* at a temperature of 20° C. in a richly nutritious medium would give rise to 16,384 individuals in three days; suppress the food and in a few hours this large number would be multiplied by 64; there would be a total of 1,048,576 individuals, or more than a thousand times the number of *Ichthyophthirius*.

New Genus of Parasitic Infusoria.‡—Prof. M. Braun has a note on a new genus of parasitic infusorians lately described by Herr Lindner, and examined also by Prof. Bütschli; it is a peritrichous form first found at Cassel in water containing organic débris; it was afterwards observed in drain water from houses and cattle-stalls; it lives in the cæcal contents of the pig, and in the fæces of typhus-patients, and even in urine. When these waters are first examined the creature is not seen, but ordinarily appears in from five to eight days. Although it has no stalk Prof. Bütschli places this infusorian with the Vorticellidæ. If its food dries up several individuals unite and become encapsuled; they multiply by longitudinal division, and that with great rapidity in suitable fluids.

It is proposed to call this new form *Ascobium*, though it is supposed to be derived from *Vorticella microstoma*, which has gradually lost its stalk from the change in its food; Prof. Braun thinks it ought not to be regarded even as a new species, but merely as the separated capitulum of a form already known.

Parasitic Protozoa in Ciona intestinalis.§—Dr. C. Parona continues his description of parasites found in the alimentary tract of *Ciona*.

In addition to that described in a previous communication ‖ a new genus is formed, which has affinities both to *Dallingeria* and *Trimastix*, to which the name of *Elvirea* is given.

The new genus has an oval body, rounded anteriorly and posteriorly. Three flagella are carried anteriorly, of which the middle one is the shortest, only one of these is used at a time; the other two are carried behind, or twisted round the body; each of the three is used alternately.

* Comptes Rendus, civ. (1887) pp. 308–10.
† See this Journal, *ante*, p. 253.
‡ Centralbl. f. Bacteriol. u. Parisitenkunde, i. (1887) pp. 204–5.
§ Journ. de Microgr., xi. (1887) pp. 25–8.
‖ See this Journal, 1886, p. 106.

The nucleus and nucleolus are situated in the middle of the anterior part of the body.

The differences from the above genera are exhibited in the following table:—

Trimastigidæ (3 flagella)	All three active		*Callodictyon.*
	Two active, one training		*Trichomonas.*
	One active, two training	Animal free or fixed	*Dallingeria.*
		Animal always free, and without undulating membrane	*Elvirea* (nov. gen.)
		Animal free, but with undulating membrane	*Trimastix.*

The author considers that of these *Callodictyon* is the lowest, and that a gradual differentiation can be traced through the other forms to *Elviria*, which is always free; and this is more perfect than *Trimastix*, since the latter possesses a membrane. The third parasite dealt with is also probably new to science, but the author leaves it undetermined at present, since only one specimen was noted. This is a Ciliate Infusorian, elongated, attenuated in front, enlarged behind. It is transparent, highly retracting, and slightly granular; there are four or five non-contractile vacuoles in centre, and three in posterior of body. Nucleus anteriorly. The sides, and posterior parts of body are deprived of cilia, and these are very short; anteriorly the cilia are strong and stout.

BOTANY.

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

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Protoplasm.†—In a report of very elaborate researches on the nature of protoplasm, Dr. G. Berthold maintains the old view that it is to be regarded as a highly complex emulsion, differing in consistence in the different cases; and that the forces upon which the changes of form, internal movements, and so forth, depend, are the same as those which determine whether a fluid shall assume the form of a drop, or drops, or spread out and wet another body, and so on—in fact, the forces concerned in surface-tensions.

To take an example of a typical cell:—a spore of *Equisetum* may be regarded as a system of concentric layers. First there is a central nucleus; then various layers of protoplasm, of which the innermost is colourless and contains certain minute granules, the second is thicker and carries the chlorophyll-corpuscles, the third is hyaline, and contains lenticular refractive bodies of peculiar nature; then follows the cell-wall, if nothing further. The cell-wall is usually composed of three or more layers. If we consider the cells of a tissue, Berthold points out that a given partition membrane must be regarded as dividing and belonging to two symmetrical plasmatic systems, and as being their middle and innermost layer.

But all cells are not systems of concentric layers. Not only are

* This subdivision contains (1) Cell-structure and Protoplasm; (2) Other Cell-contents; (3) Secretions; (4) Structure of Tissues; and (5) Structure of Organs.

† Berthold, G., 'Studien über Protoplasmamechanik,' Leipzig, 1886. See Prof. H. Marshall Ward in Nature, xxxv. (1887) p. 300.

excentric layers found, but a complexity is introduced as soon as the sap-vacuoles appear, in many cases making the cell not monocentric but polycentric. The *normal* order of the layers, as exemplified by the spore of *Equisetum*, or any simple cell with one large vacuole, &c., may be distinguished from the *inverse* order exhibited, for instance, by the cords in a *Caulerpa*, or the central mass in a cell containing raphides, or anywhere where the sap bathes the system of layers referred to.

It is then shown that in many cases where oil-drops, &c., have usually been regarded as lying free in a cell, they are inclosed in an ingrowth from the cell-wall, reminding us of cystoliths. An examination of intercellular spaces follows: the most interesting question is as to the existence of protoplasm in lacunæ between cells. Berthold goes much further in this respect than other writers. He finds a thin layer of protoplasm overlying the cuticle of the epidermis and of spores, and concludes that the cell-wall is formed and imbedded in protoplasm, and not excreted on its surface—the cell-wall is a supporting apparatus, not a protective one. Again, a cell forming part of a tissue cannot be forthwith compared with a unicellular alga, for this reason: the latter may be regarded as consisting of two parts, (1) the inner protoplasmic system with its contiguous share of cell-wall, (2) the outer strata of cell-wall *plus* the hypothetical covering of protoplasm. Only the first of these two parts of the algal cell can be compared with a tissue-cell.

The second chapter is concerned with the finer structure of the cell-nucleus, chlorophyll-corpuscles, and other cell-contents. It is stated that starch is not formed in the Melanophyceæ, and that the word "microsome" has no definite meaning, and had better be discarded.

If protoplasm is an emulsion, it follows that the various processes of separation of sap-vacuoles, oil-drops, crystalline and other particles, have to be explained as according with similar separations in lifeless mixtures; and this the author maintains to be the case.

The supposition that anything is explained by regarding protoplasm as essentially "living proteid," is severely criticized, and the author agrees with Baumann that the arguments which exalt proteids into the position of being the most essential constituent of protoplasm would apply equally well to water. The "living substance of organisms" is always an extremely complex mixture. Berthold proposes to recast the definition of protoplasm, and to subordinate to it—the fluid mixture absent from no living cell—cytoplasm, nucleus, chlorophyll-bodies, vacuoles, tannin and oil-drops, &c., as so many parts of the protoplasm as a whole.

In the third chapter is an analysis of the movements of naked masses of protoplasm. All turns upon the tendency of a mass of protoplasm to assume the form of a spherical drop; this can only be due to the same causes which impel a drop of any accepted liquid to assume the drop condition. The amœboid condition depends upon the degree of wetting of the environment by the fluid protoplasm, and *vice versâ*. If three fluids which do not mix are in contact with one another, the tensions at their surfaces can be mathematically investigated, and Berthold maintains that the principles here concerned govern the behaviour of a drop of protoplasm as they do that of an ordinary liquid under the given conditions. The phenomena of spreading out, putting forth and withdrawing pseudopodia, rounding off, &c., are due to the same causes and ruled by the same laws as the flowing of one liquid over another, or its withdrawal from it (glycerin and alcohol, for example), or its assumption of the drop form, and so on.

The fourth chapter deals with the symmetry or arrangement of the cell-contents. The stratified or shell arrangement is again expressly referred to,

and an attempt made to explain it on the main assumption of the book. The arrangement referred to is a consequence of exchanges (diffusion, absorption, &c.) with the environment: passive particles suspended in the cell would have to assume positions which are definite; active particles (i. e. particles which themselves exchange with the layer in which they are imbedded) might interfere with the simple shell arrangement, and we have systems within a system. After examining what occurs in the case of a spherical system or cell, the author extends the analysis to an ellipsoid and other anisodiametric systems, and finds the results accord with what is found in nature. The question of the "Hautschicht" is then attacked, and De Vries' late statements as to the existence of a pellicle or "wall" around the vacuole are criticized. Berthold condemns this pellicle as an artificial product—a "precipitation-membrane"—in many if not in most cases.

The fifth chapter is concerned with showing that, in spite of the great variety of forms exhibited by the chlorophyll-bodies of different plants, especially Algæ, their position, consistence, changes in form, division, &c., can be explained in accordance with the view that they are parts of an emulsion. Other cell-contents are considered also, oil-drops, tannin, nucleus, vacuoles, &c. The chlorophyll-corpuscles of higher plants are compared to drops resting on a substratum which they do not wet, their shape being in part due to radial pressures.

The division of chlorophyll-corpuscles is then examined, and this leads to the division of the nucleus and cell, which is treated separately. A spherical mass of fluid must increase its surface if it divides; this implies a diminution of tension at the common surface (as with the formation of pseudopodia), and concentric shells in the medium or in the mass of fluid in question. All the conditions fulfilled, pseudopodia can be formed either from the medium into the mass, or from the mass into the medium. An annular pseudopodium would divide the spherical (or spheroidal) mass into two.

This leads to the sixth chapter, where, after reviewing the process of cell-division generally, the author separates the essential from the unessential processes, and agrees with Strasburger that the division of the nucleus must be regarded as an accompanying phenomenon. The division of the ovum of *Echinus* and *Ciona* is described: soon after the male and female nuclei have fused, two centres appear in the egg, each with radii—the required bi-polarity is established. The exchanges and movements in the protoplasm are then followed; the result is that certain constituents accumulate to excess in the equator between the two radiating centres, or "suns." The two "suns" are the centres of the future daughter-cells; the still single nucleus lies between them in a bridge of the same protoplasm as that in which the "suns" are imbedded: the more peripheral protoplasm of the cell (ovum) has accumulated chiefly round the nucleus—i. e. in the equatorial plane. This equatorial protoplasm then begins to cut in two the nucleus, which has assumed the "karyokinetic" condition. The superficial shells of protoplasm are assumed to put forth pseudopodia between the "suns"—i. e. the author regards it as fundamentally a wetting process, due to changes at the surfaces; the processes are essentially of the same nature in vegetable cells.

The seventh chapter treats of the cell-network of plants, and the directions of cell-divisions, &c. It is in great measure a criticism of Sachs's view of the structure of the higher plants. Two main principles are employed. (1) The cell-divisions are, as a rule (at least in growing-points, &c.), halvings—i. e. each daughter-cell has the same cubic contents. The shape

of a segment does not forthwith enable us to judge of its relative contents, and difficulty occurs sometimes on this account. (2) The second fundamental principle is that which regulates the position of fluid lamellæ elsewhere—the principle of least areas. The rule is that the new cell-wall takes such a direction that its area is the smallest possible. There are exceptions, e. g. cambium cells; but at least one feature appears to indicate a tendency to follow the principle—cell-walls never abut in the angles of cells. Sachs's law of rectangular division is comprehended as a particular case of Berthold's more general law: it fails where simultaneous divisions result in the formation of polygonal cells—e. g. in the embryo-sac—with walls inclined at angles greater than the right-angle.

The eighth chapter deals with the sculpturing on the interior of cell-walls, and allied phenomena; while the ninth chapter is devoted to "free-cell-formation."

Chemical reactions of Protoplasm.*—By the use of a number of chemical reagents, the application of which is specified—all of which dissolve some of the proteinaceous constituents of the cell, leaving others undissolved—Herr F. Schwarz determines the distinctiveness of the following substances, viz.—In the nucleus a ground-substance, fibrillar substance, chromatin, nucleoli, and membrane. In the chlorophyll-grains a fibrillar substance capable of swelling but never soluble, and an intermediate substance capable of both, but never a chemically differentiated membrane. In the cytoplasm a fibrillar and an intermediate substance, together with imbedded granules; no chemical differentiation of the outer and inner boundary of the cytoplasm could be determined.

(2) Other Cell-contents.

Starch in Vessels.—In corroboration of previous observations, Herr A. Fischer finds,† in fully 80 per cent. of the leaf-stalks of *Plantago major*, starch-grains in some of the vessels and tracheids; and the same was the case also with several other species of the same genus. The starch-containing tracheids are sometimes the oldest spiral vessels in the vascular bundle of the leaf-stalk, sometimes the last-formed dotted vessels; each bundle may contain one or more of these tracheids; the quantity of starch varies from a few grains to a sufficient amount completely to fill up the vessel, which always has a well-developed lignified wall. The starch-containing tracheids sometimes lie in a row one behind another, but do not extend through the whole of the leaf-stalk. By maceration and staining with anilin-blue, the author was able to determine the invariable presence of protoplasm in these tracheids, sometimes also of a nucleus. No starch-producers could be detected.

In confirmation of these observations, Herr J. Schrenk ‡ states that he finds abundance of starch in vessels in the haustoria of *Gerardia* and in the rhizome of *Aristolochia serpentaria*. In these cases it occurs, not in spiral vessels, but in vessels with bordered pits, and Herr Schrenk believes that the starch was originally produced in thyllæ.

Starch and Leucites.§—According to M. E. Belzung, grains of chlorophyll are of two different kinds, according to their origin. *Chloroleucites*, with an albuminoid skeleton, resulting from differentiation of the protoplasm,

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen.-Versamml., pp. ciii.–cviii.
† Ibid., pp. xcvii.–cii. Cf. this Journal, 1885, p. 671.
‡ Bot. Ztg., xlv. (1887) pp. 152–3.
§ Bull. Soc. Bot. France, viii. (1886) pp. 483–4. Cf. this Journal, 1886, p. 819.

and *chloroamylites*, with a ternary skeleton, originating from starch-grains. In the latter case the protoplasm of the cell takes no part in the production of the chlorophyll-grains. Starch is, however, necessary for the formation of the skeleton of both chloroleucites and chloroamylites, and for the development of the chlorophyll-pigment. When starch is wanting, chloroamylites lose their green colour and finally disappear; they are usually of a temporary character, while chloroleucites may remain during the whole life of the plant.

Composition of the Starch-grain.*—M. E. Bourquelot has made a number of observations on the chemical constitution of starch-grains, which result in the view that they are not composed of only one or two chemical bodies (granulose and amylose), as has been hitherto supposed, but of a larger number of carbohydrates.

Starch-grains coloured red by iodine.—Herr A. Meyer finds,† in seventeen different species of plant belonging to seven different families, starch-grains which take a red colour with iodine. In *Goodyera discolor* they are compound. They were examined chiefly in the endosperm of Chinese and Japanese species of *Sorghum*. They do not differ in appearance from those which are coloured blue, but are much more readily broken up; they take a rather higher temperature to make them swell; and the black cross is more conspicuous with polarized light; they are more rapidly acted on by ferments. After treatment with acids they show a distinct lamination, and are coloured only a very faint red by iodine. From their various reactions, Meyer believes that the difference between these grains and those that are stained blue by iodine is that, in addition to "starch-substance,"‡ they contain amylodextrin, and a third substance which is not coloured by iodine, and is soluble in water, probably a dextrin. Those grains which take a violet colour with iodine contain traces of amylodextrin, and perhaps also of dextrin; those which are coloured red, only a small quantity of starch-substance. He believes them to be formed, by a kind of fermentation, from the "blue" grains.

Herr F. W. Dafert§ contests several of the points insisted on by Meyer in this paper, and maintains, among others, that amylodextrin does not occur in potato-starch.

Soluble Starch.‖—Herr J. Kraus, having found, dissolved in the cell-sap of the epidermis of some *Arums*, a substance previously met with by Dufour and others in the epidermis of *Ornithogalum* and *Gagea*, has come to the conclusion that it is allied to the tannins. It gives a blue colour with iodine, chloriodide of zinc colours it rose, ferric chloride and ferrous sulphate give a brownish-green; on the other hand, potassium dichromate and Gardiner's reagent give no reactions. The substance behaves like a tannin in being developed under the influence of light, and in persisting without alteration in dead or dying leaves. That iodine should give a blue colour with tannin is not surprising, since Giessmayer has shown that a solution of tannin gives with a weak solution of iodine, in feebly alkaline water, a bright red colour, and, under certain conditions, according to Nasser, a red-purple.

* Comptes Rendus, civ. (1887) pp. 177–80.
† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 337–62 (1 pl. and 1 fig.).
‡ See this Journal, *ante*, p. 256.
§ Ber. Deutsch. Bot. Gesell., v. (1887) pp. 108–14.
‖ Ann. Agronom., xii. (1886) pp. 540–1. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 173. Cf. this Journal, 1886, p. 819.

Formation of Albuminoids in Plants.*—The following experiment, performed by Herr C. O. Müller, shows the conditions under which asparagin is formed in plants. If a portion of a plant is placed in darkness by enveloping it in black paper, while it still remains connected with the parent, and the older portions are left undisturbed, then an accumulation of asparagin is formed, which, when the light is admitted, is absorbed. This does not occur in the fully grown parts save exceptionally. This result seems to show that the formation of asparagin is independent of carbohydrates, and also that the amide formed is not a bye-product of the interchange of matter within the plant. It has also been found that even when a plant is growing under abnormal conditions when all carbon dioxide has been removed from the air, asparagin is formed in the young parts, but not in the matured portions. Consequently it appears as if light played as inconspicuous a part in the formation of asparagin as carbohydrates. The author considers that asparagin is formed by the union of inorganic nitrogen compounds and malic acid within the plant, the acid being derived from the carbohydrates.

Poulsen's Crystals.†—Sig. P. Calabrò has investigated the occurrence of these crystals in *Erythrina mitræfolia*. He finds them almost entirely absent from the root, most abundant in the stem. In the leaves there are fewer in the lamina than in the petiole. In the floral region they are few and very small. As to their constitution, the crystals consist for the greater part of pure cellulose, which, towards the base, has undergone a certain amount of lignification. The mineral constituent is calcium oxalate.

New nitrogenous constituent of the Lupin.‡—Herren E. Schulze and E. Steiger obtain, from an aqueous extract of the cotyledons of etiolated seedlings of lupin, by the addition of tannic acid and sugar of lead, acidulating with sulphuric acid, and decomposing by phosphoric-tungstic acid, a basic substance to which they give the name *arginine*. The nitrate presents the formula $C_6H_{14}N_4O_2HNO_3 + \frac{1}{2}H_2O$.

Production of Chlorophyll in an objective spectrum.§—By means of a normal objective solar spectrum, Herr J. Reinke found that the production of chlorophyll took place most rapidly on both sides of the line C, nearly in the interval $\lambda = 635$ to $\lambda = 675$; the curve falls from this maximum towards both ends of the visible spectrum. Positive heliotropism of seedlings is manifested even in the yellow when the light is sufficiently strong.

(3) Secretions.

Chemical composition of certain Nectars.‖—M. de Planta has made a complete chemical analysis of a certain number of nectars. The following is a *résumé* of the results. In the fresh nectar of *Bignonia radicans* the author found 14·84 per cent. of glucose and 0·43 per cent. of cane sugar; in the nectar evaporated to dryness, 97·0 per cent. of glucose and 2·85 per cent. of cane sugar. In the fresh nectar of *Protea mellifera* 17·06 per cent. of glucose was found, but no cane sugar; in the dry nectar

* Landw. Versuchs-Stat., 1886, pp. 326-35. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 70.

† Malpighia, i. (1886) pp. 169–75 (1 pl.).

‡ Ber. Deutsch. Chem. Gesell., xix. (1886). See Bot. Centralbl., xxix. (1887) p. 167.

§ Ber. Deutsch. Bot. Gesell., iv. (1886) Gen.-Versamml., p. cxix.

‖ Zeitschr. f. Physiol. Chem., x. p. 3. See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 212.

the percentage of glucose was 96·6. In the dry nectar of *Hoya carnosa* the percentage was 12·24 of glucose and 87·44 of cane sugar. The author states that nectar is destitute of formic acid, and that its composition varies considerably with the age of the nectariferous tissue.

(4) Structure of Tissues.

Thickening of the wall of parenchymatous cells.*—M. J. Baranetzki states the following general conclusions as the results of a study of this subject. The thickening of the soft parenchyma usually presents itself, in its mature state, in the form of a network composed of separate strings arranged in a definite manner. In the very young state of the cell-wall its thickening has always the form of a delicate network, subsequent transformation of which may produce a thickening in the form of punctations; the punctations of lignified cells have always the same origin. In the walls of parenchyma there may always be distinguished at least two, and often three superposed systems of thickening layers, characterized by special morphological peculiarities, viz. — *a*, primary membrane, altogether continuous and homogeneous; *b*, secondary thickening, having at first always the form of a network, but subsequently transformed into punctations; *c*, tertiary thickening, sometimes in the form of broad bands, sometimes of still continuous layers, which may then cover up the punctations of the secondary system.

The secondary and tertiary thickenings are produced by the successive apposition of new layers on the inner surface of the cell-wall. Those walls which have only a secondary thickening appear never to become lignified; lignification commences only with the formation of the tertiary layers, and depends on the fact that the protoplasm produces, along with cellulose, certain other soluble substances which impregnate the cell-wall. The direction of the strings of secondary thickening is determined by the general direction of growth and by the form of the wall. The secondary strings or bands are always adapted, by their form and arrangement, to protect the cell-wall in the best possible way against the pressure exercised in the plane of the cell-wall itself.

Endoderm of Senecio Cineraria.†—M. P. Vuillemin describes the structure of the endoderm of this species, which closely resembles that in *S. caudatus*. It originates, both in the stem and leaves, on the back of the fibrovascular bundles. The oleiferous canal is formed at the expense of a cell of the internal row. The outer row establishes the continuity of the amylaceous layer in the leaf and of the layer of cells with folded walls in the stem.

Cambium of the Medullary Rays.‡—On physiological grounds connected with the storage of food-materials, and with the function of the initial cells of the medullary rays, Herr A. Wieler contests Haberlandt's view,§ that the cambium of the medullary rays is a secondary meristem.

Pores of the Libriform Tissue.‖—Dr. Emily L. Gregory describes the various kinds of pore found in woody tissue, distinguishing between those which are simple and those which are bordered. The principal genera of 67 families were examined, among which there were only 8 in which the libriform tissue contains both bordered and simple pores; 18

* Ann. Sci. Nat. (Bot.), iv. (1886) pp. 135–201.
† Bull. Soc. Bot. France, viii. (1886) pp. 538–40.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 259–66.
§ See this Journal, 1886, p. 1009.
‖ Bull. Torrey Bot. Club, xiii. (1886) pp. 197–204, 233–44 (4 figs.).

contained only bordered, and 34 only simple pores; the remaining 7 varying in their different genera. The author considers it probable that there is a decided difference in function between simple and bordered pores, the latter having more especially for their object to facilitate the passage of water through the plant. With extremely few exceptions, when the libriform cells are used as reservoirs of starch, this substance is formed only in those with simple pores.

Albumen-vessels in the Cruciferæ and allied orders.*—Herr E. Heinricher finds the peculiar idioblasts already described by him in species belonging to 18 out of the 21 tribes of the order Cruciferæ. Their distribution in the various points of the plant differs in different species. In Capparideæ they were found in three species of *Capparis*, but not in *Cleome;* in the Papaveraceæ, in *Eschscholtzia;* in the Fumariaceæ, in *Adlumia* and *Corydalis*. The micro-chemical reactions showed the contents of these tubes to be always of an albuminoid character. The hypothesis that they are not simply reserve-organs, but that the proteids are formed in them, is rendered highly probable by the sharp localization of their contents, which are well differentiated from the protoplasm of the surrounding cells. They are apparently first formed at a very early period, their rudiments being visible even in the ripe cotyledons of the seeds of *Sinapis alba*. Phylogenetically the author adopts the view that they are derived from the segmented laticiferous vessels of the Papaveraceæ. In *Adlumia* and *Corydalis* these albumen-vessels are very long, and form a reticulation in the mesophyll of the leaf similar to the laticiferous vessels of *Euphorbia;* but they have blind endings.

Tannin-receptacles in the Fumariaceæ.†—Herr W. Zopf describes structures in the Fumariaceæ, which appear to correspond to the latex-tubes in the allied order Papaveraceæ. He finds them in all species examined of the genera *Corydalis*, *Adlumia*, *Dicentra*, and *Fumaria*, and in all parts both above and under ground. They take the form of idioblasts, very often of great length but undivided, containing a colourless, red, or yellow substance of the nature of tannin. They are either protogenous, formed in the primary meristem, or hysterogenous, developed in the cortex or cambium of the vascular bundles. In both cases they do not at first differ from the ordinary cells. No fusion of cells nor sieve-plate-structure was observed. A nucleus was in all cases detected, and in the longer idioblasts there are probably several.

These receptacles contain large quantities of tannin, either colourless or coloured by a yellow or red anthocyan, the latter especially in those parts which are exposed to strong light; and this is apparently the result of the action of vegetable acids. The yellow pigment is also formed in the course of development of the plant, and is preceded by a colourless substance or chromogen. There are probably a number of different anthocyans characteristic of different plants.

Formation of Cork in the Stem of plants with few or no leaves.‡—Herr H. Ross has investigated the structure of the stem in relation to the development of cork in a number of plants in which the stem is nearly or quite leafless. He finds that in such plants, where the stem is perennial, assimilating tissue is always formed in the outer cortex, and

* MT. Bot. Inst. Graz, i. (1886) pp. 1–92 (3 pls.). Cf. this Journal, 1885, p. 672.
† Biblioth. Bot., 1886, 42 pp. and 3 pls. See Bot. Centralbl., xxix. (1887) p. 39.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 362–9.

the formation of cork is usually retarded as long as possible. The periderm most often takes the form of longitudinal strips, formed in such a way as to disturb the assimilating tissue as little as possible. These strips often remain for some years; finally they coalesce, and then for the first time form an unbroken periderm, such as is developed during the first year in nearly all woody plants.

Anatomy of Menispermaceæ.*—M. R. Blottière describes the anatomical structure of typical species belonging to each tribe of this order. Its affinities he believes to be with the Lardizabaleæ. He proposes to classify the genera under five suborders, characterized by the nature of the fruit, whether drupaceous or baccate, by the number of ovules, whether one or many, and by the presence or absence of endosperm and of a laticiferous system.

Anatomy of the Stem of Orchideæ.†—Herr M. Möbius points out that in both their structure and arrangement the fibrovascular bundles in the stem of a large number of native (German) Orchideæ present a singular approach to those of Dicotyledons. The bundles are arranged in a single ring, in the uppermost portion of the stem, and show at least traces of an active cambium. The detailed structure is described in a number of different species, and it is shown that the chief differences are correlated with differences in the structure of the labellum and in other floral characters, the Ophrydeæ and the Neottieæ presenting two distinct types.

Structure and Geographical Distribution of Plumbagineæ.‡—M. P. Maury takes as his type of this order the genus *Plumbago*. The primary structure of the internal part of the root is as follows:—Inside the endoderm one or more layers of cells constitute the rhizogenous layer, enveloping the central cylinder, formed of four woody bundles in the shape of a cross, alternating with which are four liber-bundles. In the young stem the author recognizes (1) the epidermis, (2) a cortical zone of eight or ten layers of cells, (3) the endoderm, (4) the zone of liber, (5) the central cylinder formed of eight fibrovascular bundles, separated by large medullary rays, and leaving a large portion of pith in the centre. On the stems and leaves of Plumbagineæ are frequently numerous small masses of carbonate of lime, often united in a sort of crust. Their formation has been explained by Licopoli. The mother-cell divides simply into four, each of these cells is secretory, their product collects in the intercellular space, and is excreted by the tension of the cells which remain always united on their lower surface. The author states that the inflorescence of all the Plumbagineæ is constructed on the same plan. It is a mixed inflorescence formed of dichotomous cymes, developed singly by abortion, and grouped in a paniculate or capitulate manner.

M. Maury admits the axile nature of the ovule of Plumbagineæ. With regard to the affinities of this natural order, its nearest relationships are with Primulaceæ and Polygonaceæ.

The remaining portion of the memoir is devoted to the geographical relations. Of the 267 species of Plumbagineæ, 52 are European, 123 Asiatic, 39 African, 11 American, and 2 Oceanic; the remaining 40 are common to two or more continents.

* Blottière, R., 'Étude anatomique de la famille des Menispermées,' 71 pp. and 2 pls., Paris, 1886.

† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 284–92 (1 pl.).

‡ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 1–134 (6 pls.).

(5) Structure of Organs.

Origin of the lateral roots in Leguminosæ and Cucurbitaceæ.*—MM. P. van Tieghem and H. Douliot dissent from the statement of Janczewski, that the secondary roots of Leguminosæ and Cucurbitaceæ are formed in a different way from those of other orders of Dicotyledons. They repeat their previous assertion that the young secondary root derives its nutriment from the cells of the mother-root with which it comes into contact. This may take place in three different ways:—(1) The young lateral root is naked, and its digestion is then direct and complete, as in Ferns, Cycadeæ, Conifers, Cruciferæ, Caryophyllaceæ, various Monocotyledones, &c. (2) The young lateral root pushes before it a more or less thick layer of protoplasmic tissue, which continues in a state of activity, and which digests the tissues with which it comes into contact; this layer of tissue they propose to call the *digestive pouch* (*poche*). The digestion is here indirect and partial. (3) This pouch soon disappears from the sides of the lateral root, remaining intact only at its apex; this case is intermediate between the other two. This digestive pouch has been described by previous writers as a false root-cap. The layer of tissue which envelopes and protects the apex of a lateral root is called by the author the cap (*coiffe*) independently of its origin; the portion which belongs to the surrounding tissue they now propose to call the pouch, that which belongs to the lateral root itself the *calyptra*. The lateral roots of Leguminosæ and Cucurbitaceæ have their origin, equally with those of other Dicotyledones, in the pericycle of the primary root or of the stem; their mode of growth is by means of a strongly developed pouch.

Origin of Lateral Organs.†—Herr G. Karsten supports Sachs's statement that the phenomena of growth in plants may all be referred to a common principle, viz. rectangular segmentation. He finds this to be the origin of the secondary roots in all the plants examined, whether monocotyledonous or dicotyledonous. In opposition to Janczewski, he states that the differentiation of the meristem takes place only at a comparatively late period. In *Lycopodium* and *Selaginella* he finds no apical cell in the young leaf-papillæ. As regards Gymnosperms, he agrees with Strasburger rather than Dingler, finding no apical cell either in the rudiments of the leaves or in the growing-point of the stem. In Angiosperms (*Elodea*, *Hippuris*, *Utricularia*) the leaves have the same origin from the growing-point, brought about in all cases by rectangular segmentation of a group of cells, and not by segmentation of a single apical cell, as in mosses and ferns.

Tubers on the Roots of Leguminosæ.‡—Herr F. Benecke confirms the conclusion of Brunchorst,§ that the "bacteroids" found in the tubers on the roots of Leguminosæ are not living bacteria, although endowed with a constant swarming motion, but are ordinary protoplasmic structures of the cells, and the tubers receptacles of food-material. His principal argument in support of this view is that, in *Vicia Faba*, if half of the apex of the root is removed, and the other half gradually developed into a normal root by water-culture, the tubers do not make their appearance until the root has assumed its normal structure, and then in that part which no longer shows any trace of injury.

* Bull. Soc. Bot. France, viii. (1886) pp. 494–501. Cf. this Journal, *ante*, p. 262.

† Karsten, G., 'Ueb. d. Anlage seitlicher Organe,' 32 pp., 3 pls., and 78 figs., Leipzig, 1886.

‡ Bot. Centralbl., xxix. (1887) pp. 53-4. § See this Journal, 1886, p. 271.

Leafy branches of Cupressineæ.*—According to Herr P. Klemm, the principal differences in the anatomical structure of the branches of Cupressineæ depend upon whether they are radiar, bilateral, or dorsiventral, a point which is apparently dependent largely on the illumination. The epidermal cells have a row of pores on their side-walls, the pores of adjacent cells usually corresponding. The cuticle is often covered with a coating of wax, and has usually crystals of calcium oxalate imbedded in it. Besides the central and peripheral stereome, there are also often stereids in the parenchyma, which are generally idioblasts. The palisade-parenchyma is on the morphologically under side of the leaf; the cells of the abducting tissue are elongated in the longitudinal direction, those of the conducting and assimilating tissues in the transverse direction. The conducting system presents no special peculiarities. The stomata are usually on the non-illuminated side, where there is no palisade-parenchyma; their structure is quite of the ordinary kind. The resin-receptacles are either entirely imbedded in the parenchyma, or they are adjacent to the epidermis, causing the formation of channels or pits.

Transparent Dots in Leaves, especially of Connaraceæ.†—Dr. L. Radlkofer describes the various points of structure which give rise to the appearance of more or less transparent dots in species belonging to a large number of different natural orders. Those belonging to the Connaraceæ, especially the genera *Connarus* and *Rourea*, are described in detail, and the value of the character for taxonomic purposes is discussed. A new genus *Pseudoconnarus* is proposed, formed out of *Connarus fecundus*, and distinguished from the typical genus by the absence of dots on the leaves.

Foliar Lenticels.‡—In investigating the large lenticels on the leaves of *Camellia japonica*, Prof. A. Borzì finds that they are essentially connected with the stomata, which are of two kinds. At the time when the young leaves first emerge from the bud, there is no visible trace of lenticels. There are two different sets of stomata, formed at different periods, the first set controlling the respiration during the earlier, the second set during the mature period of the leaf. The epidermal cells from which the second set is formed show scarcely a trace of segmentation at the time when the first set are mature. As soon as the first set become useless by the formation of the second set, their guard-cells are transformed into a corky cushion; and at the same time the subjacent cells of the mesophyll divide by tangential septa, and their walls become suberized. In this way is formed a true lenticel.

The lenticels on the petioles of *Aralia papyrifera* and *Sieboldii* have the form of corky emergences, but present no special points in their structure or mode of origin.

Ochrea of Polygonaceæ.§—According to M. Colomb the ochrea of the Polygonaceæ is a compound structure, composed of two portions, one opposed to the leaf, which is its sheath, the other situated in its axil, and detached from the petiole, which is a ligule. A similar structure occurs in the stipules of *Ficus* and *Magnolia*.

Epidermal Glands containing an Ethereal Oil.‖—Herr J. Behrens describes the well-known multicellular glandular hairs of *Pelargonium*

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 499–541 (4 pls.).
† SB. K. Bayer. Akad. Wiss., xvi. (1886) pp. 299–378.
‡ Malpighia, i. (1886) pp. 219–27 (1 pl.).
§ Bull. Soc. Bot. France, viii. (1886) pp. 506–7.
‖ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 400–4.

zonale, and states that the usual description is inaccurate which places the seat of the formation of the oil between the cuticle and the inner layer of the epidermis. It is first formed in the protoplasm itself, though at a later stage a membrane makes its appearance between the oil-drop and the protoplasm. The oil-glands on the margins of the stipules of *Erodium cicutarium* retain permanently the earlier structure of those of *Pelargonium*, and the same is the case also with those on the sporangia of *Pteris serrulata*. In *Ononis spinosa* the very thin oil found in the protoplasm passes entirely through the outer wall of the gland. The transverse walls of the pedicel-cells of the gland are perforated by a large number of minute pores, through which threads of protoplasm pass from one cell to another. A similar passage of oil through the outer membrane takes place in the glands of *Senecio viscosus*.

Structure of Flowers of Cleome.*—By observations on two species of *Cleome* (*C. spinosa* and *gigantea*) Herr F. Hildebrand confirms the statement of Vöchting † with regard to the movements of the floral organs resulting from gravitation. He finds that, as the position of the flower in this respect is altered, the stigmas and anthers always place themselves in such positions that they are not in contact with one another; the object being apparently to promote cross-fertilization.

Cleistogamous Flowers of Orobanchaceæ. ‡—**M. L.** Trabut describes a peculiar kind of cleistogamous flower which he has detected in *Phelippæa lutea*, an Orobanchaceous plant from the province of Oran. They are situated below the ordinary flowers, buried in large scales, and produced beneath the surface of the soil. They appear later than the ordinary flowers, and produce smaller capsules, containing seeds in no way differing from the ordinary ones.

Doubling of Flowers.§—Herr F. Hildebrand points out that the doubling of flowers is always a morbid phenomenon, and of no use in nature; the marking of the petals which assists insect-visitors in finding the way to the nectary is usually lost. The tendency to an abnormal development of the corolla (or calyx) varies greatly in different families; in many cases it is so feeble that it is exceedingly difficult in them to obtain double blossoms. External influences can only act on this predisposition in the species to a doubling of the floral organs.

Mimetic Pollen-grains.‖—Herr J. M. Janse records a remarkable instance of mimetism in the flowers of *Maxillaria Lehmanni*, from Central America. On the central region of the labellum is a callosity which is covered by a fine yellow powder which bears an almost exact resemblance to a layer of detached pollen-grains. The author suggests that they are taken for pollen-grains by bees, which devour them eagerly for the large quantity of starch which they contain. In moving about the labellum to feed on this substance, the insect would necessarily strike against the anther, and remove the pollinia with their viscid discs. The substance in question appears to be an epidermal structure, consisting of the detached nearly spheroidal constituent cells of moniliform hairs. Herr Janse believes that this is the first instance recorded of the occurrence of starch in hairs.

* Ber. Deutsch. Bot. Gesell., iv. (1836) pp. 329–37.

† See this Journal, *ante*, p. 266.

‡ Bull. Soc. Bot. France, viii. (1886) pp. 536–8.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 622–41. Cf. this Journal, *ante*, p. 266.

‖ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 277–83 (1 pl.).

Mechanism of Fruits for the Purpose of Dispersion.*—Herr G. Eichholz describes the arrangement in a number of fruits by means of which the bursting or twisting is brought about which promotes the dispersion of the seeds. This is generally effected by the adaptation of certain cells, either from their first formation or shortly before they become ripe. These special cells may be arranged in two groups, according as they contract most strongly, on desiccation, in the longitudinal or in the transverse direction. The curve in the tissue resulting from unequal contraction of these elements may be either double or single; and in the latter case may result from contraction of the concave or from elongation of the convex side.

As regards the details of the structure in special cases:—In *Impatiens* the layer of pericarp which swells is a mechanism resembling a bladder which is drawn out by hydrostatic pressure. The change of form of the cells determines the direction, the great extensibility of the membranes the extent of the expansion. The fibrous or resisting layer has very little flexibility, but great traction. In Rutaceæ the endocarp has a hinge-structure. In *Dictamnus*, but not in *Ruta*, the endocarp is thrown out together with the seeds. In the Rutaceæ, Liliaceæ, and Rhodoreæ the curvature is brought about by the dynamo-static elements being placed transversely on the concave, vertically on the convex side. In *Fagus*, *Epilobium*, and *Datura*, the thin-walled parenchyma is the contracting tissue. In *Epilobium* the median vascular bundle takes no part in the contraction. In *Pinus*, *Eschscholtzia*, *Acacia*, *Acanthus*, and *Scandix*, the curvature is the result of a constant difference in the direction of the pores in the fibrous elements. The isodiametrical thick-walled cells of *Weigela*, *Azalea*, and *Rhododendron* have two functions; they contribute to the curvature in a vertical plane; and they cause also the curvature in a horizontal plane, which is essential for the perfect release of the seeds. The isodiametrical cells of *Primula* exercise a traction in the vertical direction only.

β. Physiology.†

(1) Reproduction and Germination.

Fertilization of Orchideæ.‡—M. L. Guignard confirms the statement of previous observers that the formation of the ovules in Orchideæ is the result of the activity of the pollen-tubes.

In *Vanilla aromatica* the pollen-grains germinate a few hours after being placed on the stigma, which is covered by a gelatinous secretion. The ovary, which, at the period of pollination, is about 4 cm. long, immediately begins to lengthen, until it attains a length of about 20 cm. At the same period the ovules have merely attained the state of small papillæ on the placenta. On the fifth or sixth day after pollination the nucellus is visible at the summit of the papilla, which then begins to curve on the funicle. On the eighth day the inner integument begins to be formed by division of the epidermal cells; the formation of the outer integument follows, and the mother-cell of the embryo-sac increases in size at the summit of the nucellus beneath the epidermis. On the twelfth day the ovule has become anatropous; the internal coat reaches almost to the summit of the nucellus; the outer coat is still very short, but passes the internal coat about the twentieth day. During this time the mother-cell of the embryo-

* Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 543–90 (4 pls.).

† This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth; (3) Movement; and (4) Chemical Changes (including Respiration and Fermentation).

‡ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 202–40 (2 pls.). Cf. this Journal, 1883, p. 84.

sac has divided into three superposed cells, the two upper of which disappear and the lowermost develops into the embryo-sac; in this the sexual apparatus consists of a large oosphere and two synergidæ with very thin membranes. This apparatus is definitely constituted, in most of the ovules, rather more than a month after pollination; five weeks later impregnation commences, and is completed in about a week.

The pollen-grain has two nuclei, which are always found near the extremity of the pollen-tube; the hinder one, which is the generative nucleus, usually divides into two. The tubes arrive at the base of the cavity of the ovary about twelve or fifteen days after pollination; they do not penetrate into the micropyle of the ovule until after the formation of the sexual apparatus.

In *Vanda tricolor pallens* the interval between pollination and fecundation is about six months; in *Angræcum superbum* about four months; in *Phajus grandifolius* two months; in different species of *Cypripedium* from three to four months; in *Saccolabium giganteum* the ovular papillæ have not even made their appearance one month after pollination. In European orchids the process is more rapid. In *Orchis Morio* there is an interval of fifteen days; in *O. latifolia* three weeks; in *O. Simia* thirteen days; in *O. ustulata* and *pyramidalis* eight to ten days; in *Gymnadenia conopsea* fifteen days; in *Ophrys arachnites* three weeks; in *Limodorum abortivum* twenty-five days.

The pollen-tubes enter the ovary, through the conducting tissue of the gynostemium, in six bundles, which pass down the angle formed by each placenta with the wall of the ovary, while the ovules are still quite rudimentary. Contrary to the statement of Degagny,* he finds that many of the tubes have transverse septa.

M. Guignard confirms the observation of Van Tieghem,† of the production by the passage of the pollen-tube of a kind of ferment, and regards the development of the ovules as a kind of hypertrophy resulting from access of abundance of nutriment. He compares it to the action on vegetable tissues of such parasites as *Synchytrium* and *Plasmodiophora*.

Fertilization of Verbascum.‡—M. P. Maury has closely examined the mode of pollination and impregnation in several species of *Verbascum*, as well as the development of the stamens. The formation of the anther-lobes and of the mother-cells of the pollen-grains occurs at a very early period. Pollination takes place at the moment of the dehiscence of the anther; but, all the species being decidedly proterandrous, the mode of fertilization is indirect or entomophilous. The most remarkable fact connected with impregnation, is that, at the period of pollination, the ovules are still in a rudimentary condition, and altogether unfit for fertilization. The nucellus is entirely occupied by the embryo-sac, in the protoplasmic contents of which there is as yet no differentiation of oosphere, synergidæ, or antipodals. It is only after the pollen-tube reaches the micropylar canal that these begin to be formed. There being no nectary in any species of *Verbascum*, insects appear to be attracted mainly by the coloured hairs attached to the filaments and by the striæ at the base of the corolla.

Fertilization of Greenland Flowers.§—Prof. E. Warming has examined the flora of Greenland between lat. 64° and 69° 15′, especially from the

* See this Journal, 1886, p. 273.

† Ibid., *ante*, p. 273.

‡ Bull. Soc. Bot. France, viii. (1886) pp. 529–36.

§ Overs. K. Danske Vidensk. Selsk., 1886, pp. xxv.–xxxiii. (French résumé), and 101–59 (13 figs.).

point of view of the mode of pollination of the flowers. As compared with Arctic Norway, Greenland is very poor in insects, and the flowers display a corresponding increased tendency to autogamy. This is well illustrated in *Menyanthes trifoliata*, which, instead of being heterostylous, as elsewhere, has become completely isostylous. 138 species of anemophilous plants are named, exclusive of the willows. The entomophilous flowers of Greenland all possess nectar; but the number of scented flowers is small. The flowers appear to decrease in size with the increase of latitude; and the brilliancy of colour certainly does not become greater. There are a considerable number of unisexual entomophilous flowers. The author has made no exact observations on the species of insects visiting the flowers.

Pollination of Flowers.*—Dr. J. M'Leod has observed that if pollen-grains are thrown into a weak aqueous solution of sugar, they will, in a few hours, all burst or put out their pollen-tubes; but that if the solution is made more concentrated, the putting out of the pollen-tubes will cease. For each species there is an optimum concentration, and a maximum concentration, beyond which no emission of pollen-tubes takes place. In the case of heterostylous flowers (*Primula elatior*, *Hottonia palustris*), he finds the maximum concentration to be lower for the small than for the large pollen-grains. Dr. M'Leod adds a series of observations on the visits to flowers of night-flying moths, and of the mode of insect-pollination of a number of species from different localities.

Germination of the Cocoa-nut Palm.†—Prof. J. von Sachs describes the development of the seedling cocoa-nut. At the commencement of the germination the young embryo, only a few millimetres in size, is split in two by the growth of the cotyledon, its basal portion, which contains the growing-point of the stem, penetrating into the hard putamen, and putting out the first roots and shoot. At the same time, there is formed at the apical end of the cotyledon a swelling of very loose tissue, the haustorium, which eventually attains the size of a small onion. This organ gradually consumes the whole both of the milk and the endosperm, carrying the nutrient material to the growing seedling, and, at the same time, excreting a ferment. By this time, which occupies about two years in cultivation, but probably a much shorter time in the tropics, four or five leaves have been formed.

(2) Nutrition and Growth.

Absorption of Carbonic Anhydride by Leaves.‡—MM. P. P. Dehérain and L. Maquenne cite determinations which confirm the conclusions already arrived at by them, namely, that the absorption of carbonic anhydride by vegetable tissues is a true phenomenon of solution varying with the temperature, as in all cases of absorption of gas by an inert solvent; consequently, when the leaf respires in an atmosphere kept at constant pressure, this gives rise to a supersaturation comparable with that of a mass of water into which calcium carbonate and hydrochloric acid have been introduced simultaneously. This absorption of carbonic anhydride by leaves is extremely rapid, at any rate when the leaves are in a vacuum, in consequence of the large surface exposed.

Increase in thickness of Palm-stems.§—By examination of the stem of a considerable number of species of palm, the late Prof. A. W. Eichler con-

* Bot. Centralbl., xxix. (1887) pp. 116-21, 150-4, 182-5, 213-6.

† SB. Phys.-Med. Gesell. Würzburg, 1886, pp. 20-3.

‡ Ann. Agronom., xii. (1886) pp. 526-34. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 172. Cf. this Journal, 1885, p. 678.

§ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 501-9 (1 pl.).

firms De Bary's view that the increase in diameter of the internodes of palm-stems is due to the increase in volume of the elements already in existence, rather than to any fresh formation of cambium. Prof. Eichler found this increase to be on the average not less than that of the stems of Dicotyledons and Conifers. The capacity for this increase in size on the part of the elements may be retained for a very long period.

Growth of Pollen-grains.*—By observation of the proportion between the amount of carbon dioxide evolved, and that of oxygen absorbed, M. L. Mangin finds that the growth of pollen-grains is effected in three different ways. In the case of grains containing abundance of starch, such as those of *Betula verrucosa*, *Iris pseudacorus*, *Plantago major*, the hazel, hornbeam, poppy, &c., their germination is independent of the nutritive substratum, they consume their own reserve-material, and the production of carbon dioxide remains constant. In grains containing no starch, such as those of *Agraphis nutans*, *Narcissus pseudo-narcissus*, *Gentiana lutea*, *Digitalis*, *Vinca*, &c., they obtain their food-material from the outside, and then disengage a large amount of carbon dioxide. In some Coniferæ and in *Nymphæa alba*, the reserve of starch in the pollen-grains does not disappear, but fresh supplies are formed in the cavity of the pollen-grain and in the pollen-tube, which are used up by the latter in its developement. M. Mangin's observations were made on pollen-grains made to germinate artificially in a nutritive medium, such as glycerin or a solution of sugar.

Ripening of Seeds.†—M. A. Muntz states that unripe rye-grain contains a notable proportion of synanthrose, a sugar analogous to cane-sugar, and only found up to the present time in the roots or tubercles of certain Compositæ. The proportion in the dry grain varied between 45 per cent. and 6·85 per cent. Young colza seed contains cane-sugar and a reducing sugar having the rotatory power of invert-sugar; at maturity cane-sugar alone remains. By determining from time to time the sugar, starch, oil, and nitrogenous matter in a constant number of colza seeds, the author finds that the glucose diminishes gradually and disappears, the cane-sugar increases, the starch, always present in small quantity, gradually diminishes, the nitrogenous and oily matters constantly increase. It therefore appears that the seed itself does not contain the carbohydrates which undergo transformation into oil; but that sugar and starch constantly flow there, and disappear after a short sojourn, thus probably furnishing the material out of which the oil of the seed is elaborated.

(3) Movement.

Ascent of Sap.‡—According to Prof. S. Schwendener, the most recent investigations of the movements of water in plants tend more and more to show the insufficiency of the imbibition theory, and to lead to the conclusion that the seat of these currents is mainly the cavities of the tracheïds and vessels rather than their walls. A fresh series of experiments and observations undertaken by him confirm these results. During the summer months the stems of most lofty trees contain no unbroken columns of water. The suction from the leaves and the root-pressure are not by themselves adequate to account for the rise of the sap; other factors must be sought for; these are not yet fully known; but among the more

* Bull. Soc. Bot. France, viii. (1886) pp. 512–7. Cf. this Journal, *ante*, p. 269.

† Ann. Agronom., xii. (1886) pp. 399–400. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 173.

‡ SB. K. Preuss. Akad. Wiss. Berlin, 1886, pp. 561–602 (3 figs.). Cf. this Journal, 1886, p. 1016.

important of them must be osmose and the filtration necessarily connected with it.

Prof. Schwendener specifies those natural orders in which there are no other mechanical elements than more or less thick-walled libriform cells with bordered pits; those which possess, in addition to these stereids, libriform cells with a few unbordered pits; those which have a homogeneous libriform or stereome with a few unbordered pits; and finally, those in which the different genera differ from one another on these points.

Periodicity in the Phenomena of Bleeding.*—Herr C. Kraus has detected a daily periodicity in the chemical nature of the sap exuded from cut stems (turnip, maize, sunflower, hop), indicating corresponding variations in the root-pressure. The most common sequence exhibited was:—slightly alkaline in the morning, strongly acid in midday, and nearly neutral in the evening. Before the close of the "bleeding" the sap ceased to exhibit any acid reaction throughout the day.

Absorption of Water by Terrestrial Organs.†—Herr L. Kny gives more in detail the experiments according to which *Dipsacus laciniatus* and *Fullonum*, alone among the plants examined, possess the power of absorbing water in the form of drops through their leaves, the latter species having it to the greater degree. Even here, however, the amount absorbed from the trough formed by the connate bases of the opposite leaves is very small compared to that supplied through the root. No very striking difference was found in the anatomical structure of the tissue of which this trough is composed, as compared with that of other parts of the plant. The author does not consider that the glandular hairs observed by Prof. F. Darwin on this part of the leaf take any part in the absorption of the water.

Structure and Coiling of Tendrils.‡—M. Leclerc du Sablon has investigated the anatomical causes of the coiling of tendrils in the Cucurbitaceæ, Passifloraceæ, Smilaceæ, and Ampelideæ, and in other genera in which they occur. He finds a constant relation between the sensitiveness of any region of the tendril and its anatomical structure. The sensitiveness of a surface is proportionate to the number of thin-walled fibres or of very elongated cells in its vicinity. Their anatomical structure is, however, only one factor in bringing about the coiling of tendrils; their form, flexibility, and movements being other factors. The author does not consider the unequal growth of the two sides of the tendril as an adequate explanation of the cause of its movements. The helicoid contraction of the free part of a fixed tendril he regards as quite independent of the extension of the coiling round a support; it should rather be compared to the spontaneous coiling of a tendril which has not reached any support.

Theory of Twining.—Herr H. Ambronn replies § to the criticisms of Wortmann ‖ on his own and Schwendener's theories on the causes of the twining of climbing stems. He charges Wortmann with confusing the elementary ideas of dextrodromal and sinistrodromal torsions, and especially contests his aphorism that "the movement of coiling is identical with circumnutation."

* Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 319–22.

† Ibid., Gen.-Versamml., pp. xxxvi.–lxxiv. Cf. this Journal, *ante*, p. 119.

‡ Bull. Soc. Bot. France, viii. (1886) pp. 480–3, and Ann. Sci. Nat. (Bot.), v. (1887) pp. 5–50 (3 pls.).

§ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 369–75.

‖ See this Journal, *ante*, p. 118.

To this Herr J. Wortmann replies * maintaining the correctness of his previous statements and theories; and the controversy is again taken up by Ambronn.†

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

Respiration and Growth.‡—Herr W. Palladin gives the result of a number of experiments on a variety of plants, from which he draws the following general conclusions:—The changes in the process of respiration under the influence of growth have a qualitative, but no quantitative character. The proportion $\frac{CO_2}{O_2}$ is less than unity during the respiration of growing organs. The result of respiration in growing organs appears to be the storing up of substances, such as organic acids, which produce turgidity in the cells. Growth ceases in an atmosphere devoid of oxygen in consequence of the cessation of the formation of these substances.

Intramolecular Respiration of Plants.§—In pursuance of previous investigations on this subject, Herr N. W. Diakonow formulates his general conclusions as follows:—That no separation of carbon dioxide, and hence no life, can exist without the access of free oxygen or the action of a nutrient material capable of undergoing fermentation; and that the processes of respiration and fermentation are mutually exclusive of one another.

Alcoholic Fermentation of Dextrin and Starch.‖—MM. U. Gayon and E. Dubourg state that they have met with a species of *Mucor* which has the power of converting dextrin and starch into sugar, and then fermenting the sugar; but, like *M. circinelloides*, it has not the power of inverting cane-sugar, and transforming it into alcohol. Other non-inversive ferments, on the other hand, have not the power of fermenting dextrin and starch. In beer-wort or solutions of glucose, this mucor developes rapidly in large spherical ferment-cellules. In dextrin or starch it at first forms mycelial tubes, which soon swell up, divide, and form themselves into globular masses. In yeast-water containing sugar, the mucor forms only a bulky unicellular mycelium. The fermentation of dextrin takes place somewhat slowly, and that of starch requires still more time. The dextrin existing in beer is readily saccharified by this mucor and converted into alcohol, if the alcohol already in the beer is expelled before adding the ferment.

Eurotium Oryzæ, used in the manufacture of "koji," secretes a diastase which converts rice into a true malt, and this fungus also inverts cane-sugar, but it cannot carry fermentation any further.

γ. General.

Chlorosis in Plants.¶—Prof. J. v. Sachs states, that, when attacked by this disease, the leaves pale and turn perfectly white; weak plants succumbing quickly. Stronger ones are attacked year after year until their reserve-material is exhausted, when they die. The touching of a diseased leaf with a dilute solution of an iron salt often causes the production of chlorophyll and cures the disease. However, from extended observations, the author

* Op. cit., pp. 414–21.
† Op. cit., v. (1887) pp. 103–8.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 322–8.
§ Ibid., pp. 411–3. See this Journal, 1886, p. 835.
‖ Comptes Rendus, ciii. (1886) pp. 885–7.
¶ Bied. Centralbl., 1886, pp. 602–4. See Journ. Chem. Soc. Lond., 1887, Abstr., p. 76.

does not think that it is altogether the absence of iron that causes the disease, as plants growing on the same soil are attacked irregularly, some escaping altogether. His experience leads him to think that the roots or conducting vessels suffer some alteration which prevents the minute quantities of iron contained in the sap from reaching the leaves. A too rapid and luxuriant growth favours the disease. The following experiment has, he considers, an important bearing on vegetable physiology. Certain acacia trees showed symptoms of chlorosis, in particular the thick branches of a twenty-year old tree. The author caused holes to be bored in the main stem, just beneath the bifurcation of the branch with the core of the tree. In these holes he placed corks fitted with funnels, charged afterwards with ferrous sulphate or ferric chloride in solution. In dry weather the tree absorbed the solutions readily, the leaves in the line of each funnel becoming quite green in 10 to 14 days, while those not in the line remained white. This the author thinks a proof that each branch and twig has its own sap-ducts.

Freezing of Tissues.*—Herr H. Müller-Thurgau gives the details of a large number of experiments connected with the freezing of tissues, especially on potatoes and on leaves. He regards the cause of the death of the protoplasm to be not so much the low temperature or the desiccation, or the processes connected with thawing, as the actual freezing itself.

Plants poisonous to Fish.†—Dr. L. Radlkofer gives a list of upwards of 150 species of flowering plants which are more or less poisonous to fish, many of which are used for purposes of fishing.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Gemmiparous roots of Anisogonium.‡—M. P. Lachmann observed in *Anisogonium* [section of *Asplenium*] certain roots, the radicular nature of which was fully determined, and which gave rise to a bud at their apices. On the exterior the passage of the root to the bud is marked by a very apparent swelling; on the interior a transition of radicular to cauline structure is noticed. These buds develop and give rise to stems with ordinary fronds.

Muscineæ.

Anatomy and Physiology of Mosses.§—Dr. G. Haberlandt enters, in great detail, into the structure of the vegetative organs of Mosses. The following is a summary of the more important conclusions arrived at, the author regarding the histological differentiation of Musci as much more advanced than is generally assumed.

(1) The epidermal system is represented by an epidermis which is usually typically developed on the sporogonium, and is sometimes covered by a coating of wax. On it are sometimes developed trichomic structures, as on the calyptra of *Polytrichum*. The tuberous stem of *Buxbaumia aphylla* has a suberous epidermis.

(2) The mechanical system consists of stereids, characterized not only

* Landwirths. Jahrb., xv. (1886) pp. 453–609 (4 pls.). See Bot. Centralbl., xxix. (1887) p. 76.

† SB. K. B. Akad. Wiss. München, xvi. (1886) pp. 379–416.

‡ Bull. Soc. Bot. Lyon, May 25, 1886. See Bull. Soc. Bot. France, viii. (1886), Rev. Bibl., p. 227.

§ Pringsheim's Jahrb. f. Wiss. Bot., xvii. (1886) pp. 359–498 (7 pls.).

by their elongated parenchymatous form and thickened walls, but by dots resembling longitudinal or oblique fissures. They are thus adapted for special mechanical purposes, either to resist flexion and traction, as in the rhizomes of *Polytrichum*, or for local strengthening.

(3) The absorbing system is especially represented by the rhizoids, which display no less adaptation for this purpose than root-hairs. In the saprophytic mosses this adaptation is particularly strongly displayed in haustorium-like structures (*Eurhynchium prælongum*), perforating appendages (*Webera nutans*), or a structure resembling the hyphæ of fungi (*Buxbaumia*). The foot of the sporogonium is usually provided with a papillose absorbing tissue.

(4) The assimilating system, frequently imperfectly developed in the leaves, is sometimes developed in its most perfect form in the capsule as a palisade-tissue (*Funaria hygrometrica*, *Bryum argenteum*, &c.); sometimes also as a spongy parenchyma rich in chlorophyll (*Physcomitrium pyriforme*, *Zygodon Forsteri*); or there are intermediate forms, as in *Webera elongata* and *Meesia longiseta*.

(5) The conducting system consists of simple or compound cauline bundles, and of foliar bundles with or without leaf-traces. The latter have blind endings in the cortex of the stem (*Mnium*), or unite with the cauline bundle (*Splachnum*, Polytrichaceæ). The seta almost always possesses a conducting bundle. The simple central bundle consists entirely of aquiferous cells which may be regarded as tracheïds of the simplest kind. Their walls are usually thin and smooth, but there are sometimes delicate reticulate sculpturings in the ends of the bundles (*Mnium punctatum*, *Bryum leucotrix*). The compound bundles of the Polytrichaceæ belong to the concentric type. The central hadrome bundle either consists entirely of aquiferous cells (*Pogonatum*, *Polytrichum*), or also of an intercalary conducting parenchyma (*Atrichum undulatum*). In *Dawsonia superba* and the rhizome of *Polytrichum*, the central cylinder is composed of aquiferous cells and a mechanical tissue. The leptome-sheath is chiefly employed in the conduction of albuminoids, and consists, when most completely differentiated, of sieve-tube-like rows of cells, between which are cells resembling cambiform (*Polytrichum juniperinum*). In the seta the central bundle is sometimes surrounded by a well-developed protecting sheath (*Funaria hygrometrica*, *Meesia longiseta*).

(6) The reserve-system is represented by the aquiferous tissue usually present in the capsule, and by small tuberous reservoirs of reserve-material, which occur in some species as shortly stalked appendages to the rhizome or protonema, as also in the parenchyma of the stem of *Buxbaumia*.

(7) The aerating system is typically developed in the sporogonium. The stomata often entirely resemble those of flowering plants in their structure and mechanism.

(8) No secreting or excreting organs have as yet been discovered in Mosses.

The author gives a special description of several saprophytic mosses. *Buxbaumia* he describes as entirely destitute of assimilating leaves. Finally he discusses the phylogenetic relationship of the various forms of Musci.

Homologies of Mosses.*—M. P. Vuillemin objects to the term alternation of generations as applied to mosses; he regards their stages of development rather as a kind of metamorphosis. In the evolution of a moss there are three phases:—(1) The thallophytic phase, reduced to what

* Vuillemin, P., 'Sur les homologies des Mousses,' 59 pp., Nancy, 1886.

is ordinarily called the protonema; (2) the bryophytic phase, the equivalent of which is peculiar to this group; (3) the phanerogamic phase, commonly called the asexual generation. The fertilized oosphere of mosses, like that of Phanerogams, gives birth directly to an embryo destined to produce definite organs. This is not the case with Vascular Cryptogams, and the Muscineæ are hence less differentiated from Phanerogams than are Vascular Cryptogams, in which the stem, root, and leaf are developed directly at the expense of the oosphere. The sporogonium of mosses is a derivative of the tigellum, in the same sense as the stem of higher plants; in the foot and the sporogonium are found all the anatomical regions of the stem, cortex, epidermis, endoderm, pericycle, and medulla. The spores originate from the pericycle.

Heterosporous Muscineæ.*—In addition to the examples already given, Herr C. Warnstoff records the occurrence of microspores in *Sphagnum cuspidatum* and *cymbifolium*. He believes them to be not accidental structures, but to be homologous to the microspores of the heterosporous vascular cryptogams, probably producing on germination a male prothallium.

Herr Warnstoff has also detected two kinds of spore in some Hepaticæ, especially in *Blyttia Lyellii*. The long cylindrical capsules, which split into four lobes, contain both large roundish-tetrahedral and small spherical spores, the former having a diameter of from 0·021 to 0·025 μ, the latter from 0·012 to 0·016 μ. Though the germination of the spores has here also not been actually observed, he believes that the macrospores produce female, the microspores male individuals.

Distribution of Mosses.†—M. R. Hult describes in detail the moss-flora of Finnish Lapland, amounting to 285 species, including 54 Hepaticæ and 15 Sphagnaceæ. He discusses the causes which are most efficacious in promoting the distribution of mosses, and gives reasons for doubting the prevalent theory that it is mainly due to the spores being carried great distances by the wind.

Algæ.

Gelatinous Sheath of Algæ.‡—Herr G. Klebs has examined critically the structure and origin of the gelatinous sheath which invests the filaments of many algæ, and also some Flagellata.

In the Zygnemaceæ this sheath is composed of a substance entirely independent of the cell-walls. It consists of two portions:—a homogeneous substance which is but slightly refringent, and which is indifferent to the action of staining reagents, and a portion which absorbs pigments (methyl-blue, methyl-green, vesuvin, &c.) with avidity, and which is composed of minute rods at right angles to the cell-wall. Under the action of Prussian blue it swells, becomes irregular, and finally disorganized. These reactions are exhibited only by the sheath of the living plant. Its substance does not comport in its reactions with the ordinary mucilage of vegetable cells; it is not dissolved by alkalies; treated with hot water or with chloriodide of zinc it loses its power of absorbing pigments. The author maintains that the substance of the sheath is derived directly from the cytoplasm of the cells through the cell-wall. It is always quite distinct from the cell-

* Verhandl. Bot. Ver. Prov. Brandenburg, 1886, pp. 181–2. See Bot. Centralbl., xxix. (1887) p. 198. Cf. this Journal, 1886, p. 830.

† Acta Soc. pro Fauna et Flora Fennica, iii. (1886). See Bull. Soc. Bot. France, viii. (1886) Rev. Bibl., p. 193.

‡ Unters. Bot. Inst. Tübingen, ii. (1886) pp. 333–418 (2 pls.).

wall, and must be formed by apposition and not by intussusception. This was shown by the mode of deposition in the sheath of particles of salts of iron and lead when the alga was grown in dilute solutions of these salts. The passage of its substance through the cell-wall can be proved in a similar way.

The structure and origin of the gelatinous sheath in the Desmidieæ is essentially the same as in the Zygnemaceæ; this is also the case with *Chætophora* and *Sphærozyga*.

In *Chroococcus helveticus* the gelatinous sheath is homogeneous and capable of swelling, in *Glœocystis ampla* it is composed of two successive layers. The stalk of some diatoms (e. g. *Gomphonema*) is composed of a gelatinous substance the density of which increases towards the outside; it swells but slightly, but is intensely coloured by anilin pigments. It is entirely independent of the cell-wall.

Among the Volvocineæ the gelatinous sheath of *Glœomonas ovalis* swells greatly, that of *Pandorina* less, that of *Gonium* and *Eudorina* least of all. The rod-structure is distinct in *Pandorina* and *Gonium*, less so in *Eudorina*, while the sheath of *Glœomonas* is apparently homogeneous. In *Volvox* the separate individuals of a colony have no distinct sheath of their own, but lie immersed in a common gelatinous mass which fills the interior of the sphere. This gelatin is traversed by delicate strands of a denser and more resisting material. Towards the periphery may be detected a membrane of polygonal outline derived from the original walls of the separate cells.

A gelatinous sheath can be detected in nearly all the Flagellata by the use of sufficiently dilute staining materials; and this sheath is evidently due directly to the activity of the protoplasm. In *Euglena sanguinea* it is secreted in the form of straight or more or less curved filamentous bodies. In the social forms the gelatin consists of a fundamental substance, immersed in which are denser granular corpuscles. Both substances are coloured by anilin-pigments. The brown or black colour of the sheath of these colonies is due to the deposition of oxide of iron.

Anatomy and Development of Agarum Turneri.*—Mr. J. E. Humphrey states that the anatomy of the Laminariaceæ shows great uniformity; taking place, in this as in other species, by intercalary growth at the junction of stipe and lamina. A pith, an internal cortex, an external cortex, and an epidermis containing the coloured pigment, are here to be distinguished. In young specimens the pith is not differentiated, the differentiation only taking place slowly. M. Reinke has described a zone of growth as existing in the Laminariaceæ; this zone is present in *Agarum*, but is accompanied by a second sub-epidermal cambium. As for the perforations, the author shows how they are produced; the blade is covered with hollow conical papillæ, the tissue diminishes at the apex of the cones, then bursts, and the opening enlarges as the frond grows.

Marine Vaucherias.†—Prof. O. Nordstedt described the marine species of *Vaucheria* of the English and Scotch coasts, the thickness of the filaments, and length of the oogonia and antheridia, being accurately given. *V. sphærospora* he describes as both monœcious and dicœcious, and unites with it *V. subsimplex*.

Binuclearia, a new genus of Confervaceæ.‡—Prof. V. B. Wittrock describes under this name a fresh-water alga found at high altitudes in

* Proc. Amer. Acad. Arts and Sci., 1886, p. 195 (2 pls.).

† Scottish Naturalist, 1886, 4 pp. and 1 pl.

‡ Bot. Sällsk. Stockholm, Feb. 17, 1886. See Bot. Centralbl., xxix. (1887) pp. 60 and 89 (2 figs.).

Hungary and Norway. The genus is characterized by each cell of the cylindrical unbranched filaments containing two nuclei of unequal size; the dissepiments of the cells are also of unequal thickness. There is in each cell one parietal chlorophore. Multiplication takes place by bipartition of intercalary cells, no zoospores having at present been detected. Each vegetative cell appears to consist of two parts, one older with a larger nucleus and a thicker dissepiment, the other younger with a smaller nucleus and a thinner dissepiment. In one stage resting-cells appear to be formed in the same way as in some other Confervoideæ.

Layer of Earth composed of Algæ.*—Prof. V. B. Wittrock finds near Stockholm a layer of soil 0·2–0·6 metres in thickness, at a little depth below the surface, composed chiefly of filaments of *Vaucheria*, with which some diatoms and remains of flowering plants were intermixed. The species could not be determined.

Intermediate Bands and Septa of Diatoms.†—By the term "intermediate bands" (Zwischenbänder) Herr O. Müller designates certain bands which are found in many diatoms between the valves and the girdle-bands, formed after the development of the young valve, but before the appearance of the young girdle-band. They must be regarded, like these structures, as independent members of the cell-wall. There may be one only or several of these bands in each half of the cell; in the latter case the number in the two halves is often unequal. The space inclosed by the valves and the intermediate bands is often divided by septa, which is never the case with the space inclosed by the girdle-bands. The intermediate bands are either continuous annular portions of the membrane, like the girdle-bands, or are open bands. *Grammatophora maxima* is described as affording a typical example of a species with a single intermediate band; in *Tabellaria* each half-cell has several; and in *Odontidium hyemale* at least two; while the genus *Rhizosolenia* furnishes species with a large number of open bands which are not septated.

Movement of Diatoms.‡—In the valves of certain diatoms, Dr. O. E. Imhof describes pores through which the protoplasm is protruded in fine processes. The forms investigated were a large *Surirella* species and a *Campylodiscus* found in the alpine lakes of the upper Engadine. When the sides of the *Surirella* were disposed at right angles to the glass a row of very minute elliptical apertures could be detected along the edge of the empty valves. The protrusion of protoplasm was also observed. The four sides exhibit a large number of fine conical canals, occurring in a definite relation to the familiar markings. These canals open on the edge of the sides as noted above. Along the edge there runs a shallow gutter. Through each tubule a fine process of protoplasm is protruded, and all are connected by the strand lying along the gutter. Some permanent preparations were made. The structure of *Campylodiscus* is essentially the same. Fuller details are promised.

Diatoms of the 'Challenger' Expedition.§—The Report on the Diatomaceæ of the 'Challenger' Expedition, by Count F. Castracane, commences with a succinct but admirable account of the general structure and biology of the group. The phenomena of conjugation and of the formation

* Bot. Sällsk. Stockholm, April 27, 1886. See Bot. Centralbl., xxix. (1887) p. 222.
† Ber. Deutsch. Bot. Gesell., iv. (1886) pp. 306–16 (1 pl.).
‡ Biol. Centralbl., vi. (1887) pp. 719–20.
§ Report of the Voyage of H.M.S. 'Challenger.' Botany, vol. ii., 178 pp. and 30 pls., 4to, London, 1886.

of auxospores he looks on as only occasional modes of reproduction, and not as typical of the whole group.

With regard to the geographical distribution of diatoms, the author regards it as certain that several distinct floras exist; although it may be premature to determine finally the question of distribution according to the genera and species that inhabit different areas. The question of the dependence of life at great depths in the ocean on the penetration of sunlight is then discussed, as well as the formation of banks and deposits of diatoms.

The bulk of the volume is occupied with descriptions of the species collected, the immense majority being either new species or new varieties; each description is accompanied by a plate. The following are new genera:—

Cyclophora (Pseudoraphidieæ). Frustula tabulata, rectangula, in fascias conjuncta, rarius soluta; isthmo gelineo alterne concatenata; a fronte linearia vel parum inflata; valvis inæqualibus, quarum una loculo centrali instructa.

Dactyliosolen (Cryptoraphidieæ). Distinguished from *Rhizosolenia* by the occurrence in the course of the filaments of hyaline belts. Forma cylindrica; frustulum compositum ex pluribus annulis cellulatis; cellulis linearibus oblongis.

Corethron (Cryptoraphidieæ). Frustula cylindrica libera (?); valvis convexis, setarum radiantium corona cinctis.

Willemoesia (Cryptoraphidieæ). No diagnosis given.

Ethmodiscus (Cryptoraphidieæ). Frustula solitaria, discoidalia; valvis tenuissime et inconspicue striolatis; forma plus minus convexa, quandoque diversimode denticulata, zona connectiva punctulata.

Reproduction in a Fossil Diatom.*—Count F. Castracane describes the appearance presented by a fossil diatom from Monte Gibbio, which he identifies with *Coscinodiscus radiolatus*, consisting of the impressions of a great number of closely packed round bodies on the edge of the valve. These he believes to be impressions of embryonal forms still remaining within the mother-cell at the time of its death, exhibiting therefore a similar mode of reproduction to that which he had already observed in the case of *Podosphænia*.†

Fossil Diatoms from Umbria.‡—Count F. Castracane describes a calcareous deposit from Spoleto in Umbria, extremely rich in diatoms, especially in species of *Epithemia* and *Cyclotella*, of great size and beauty.

Lichens.

Synthesis of Lichens. §—M. G. Bonnier has succeeded in obtaining by artificial culture, in an atmosphere which has been completely sterilized, by the process of synthesis, several species of corticolous lichens, viz. *Parmelia Acetabulum* and *Physcia parietina* and *stellaris*, as well as *Lecanora sophodes* and *ferruginea* among saxicolous species. The constituent alga was a *Protococcus* or *Pleurococcus*. Two sets of experiments were made:—in the one set one of these algæ, in the other set the gonidia of a lichen, were sown in closed and sterilized cells in conjunction with the hyphæ of a fungus. In the latter case no development took place; in the former case a true lichen-thallus was obtained under the same conditions. Experiments

* Atti Accad. Pont. Nuovi Lincei, xxxviii. (1886) 6 pp. and 1 fig.

† See this Journal, 1885, p. 1041.

‡ Atti Accad. Pont. Nuovi Lincei, xxxviii. (1886) 7 pp.

§ Comptes Rendus, ciii. (1886) pp. 942–4, and Bull. Soc. Bot. France, viii. (1886) pp. 546–8.

by Pasteur's method, at high elevations in the Alps and Pyrenees, were still more successful, fructifications being in some instances developed on the lichen-thallus thus obtained by synthesis of an alga and a fungus.

Schwendener's Lichen-theory.*—M. C. Flagey gives a *résumé* of the literature for and against this theory; he sums up strongly against it, and in favour of Minx and Müller's hypothesis of microgonidia. Lichens he regards as autonomous and perfectly distinct organisms, allied with Algæ through *Collema*, and with the ascosporous Fungi through the Verrucarieæ, but always distinguishable from them by the chlorophyll contained in their hyphæ. Lichenin he considers to be an amylaceous substance peculiar to lichens, replacing the fungin of true fungi. M. Flagey lays stress on the unsatisfactory nature of the synthetical experiments of Bornet, Stahl, and others, inasmuch as they reconstructed lichens out of fungal hyphæ and the gonidia of lichens, rather than out of what they state to be their constituent elements, fungi and true algæ.

Hymenolichenes.†—M. O. J. Richard combats the view of Johow ‡ with regard to the compound nature of the genera *Cora* and *Dichonema*. He believes his statements to have been founded on imperfect observation of sterile specimens only, and confirms that of Nylander of the occurrence of apothecia on the thallus of *Cora*.

Fungi.

Formation and Liberation of Zoospores in Saprolegnieæ.§ — Dr. M. M. Hartog comes to the conclusion that the clear bands of the first stage of the zoosporange are neither cell-plates nor nuclear plates, but thinner parts of the protoplasm due to the aggregation of the greater part around distinct centres; at the homogeneous stage the protoplasm acquires an extreme perviousness to liquid, due probably to the temporary loss of the resistant layers as continuous layers; this stage is accompanied by a loss of turgidity, and in many cases by a marked contraction of the sporange. The clear spaces seen in the final separation are merely the watery liquid of the sporange, and do not represent expulsive matter; there is no evidence of the existence of the expulsive matter in the spore of any aquatic fungus, where the physical conditions are altogether different from those of the aerial ascus of the higher fungi. *Achlya* has been found to be diplanetic or to have the two tractella seen in *Saprolegnia* and *Leptomitus*. The escape of the zoospores is due to the chemical stimulus of the oxygen acting on the automotile zoospores. The author's observations were chiefly made on plants grown on mealworms in tumblers, and floated out on large glass slides for examination.

Aspergillus.‖—Herr O. Johan-Olsen describes all the species of *Aspergillus* hitherto found in Norway, with several fresh observations on their structure. He regards the various forms of sterigma as furnishing no satisfactory specific characters, *A. niger*, *albus*, and *flavus* having both forms. *A. fumigatus*, *flavescens*, and *subfuscus* develope involution-forms within the bodies of animals, the swollen spores putting out numerous spiny or club-shaped, swollen or branched protuberances united into tufts,

* Rev. Mycol., viii. (1886) pp. 5–14, 65–80, 129–36.
† Le Naturaliste, 1886, pp. 1–6. See Rev. Mycol., viii. (1886) pp. 108–9.
‡ See this Journal, 1884, p. 790.
§ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 427–38.
‖ Christiania Videnskr.-Selsk. Forhandl., 1886, p. 25. See Bot. Centralbl., xxix. (1887) p. 292.

reminding one of *Actinomyces*. These resemble the tubercular bacilli in their behaviour towards reagents, and in their pathogenic properties.

The following species are then described:—(1) *A. glaucus* Mich.; (2) *A. flavus* Bref.; developes involution-forms; *A. Oryzæ* is probably only a variety; (3) *A. fumigatus* Fres.; the involution-form causes maladies of the lungs and kidneys; (4) *A. clavatus* Desm.; not pathogenic; (5) *A. niger* van Tiegh.; pathogenic, causing diseases of the skin and breasts, but no internal mycosis; (6) *A. subfuscus* n. sp.; found within putrescent organic bodies, producing in living animals a general mycosis; (7) *A. albus* Wilh.

Development of Gymnosporangium.*—According to Prof. W. G. Farlow, the identity has now been established of *Gymnosporangium claviceps* (on *Juniperus virginiana*) with *Rœstelia aurantiaca* (on *Amelanchier canadensis*), of *G. clavariæforme* (on *J. communis*) with *R. lacerata* (on *Cratægus tomentosa*), of *G. conicum* with *R. cornuta*, and of *G. biseptatum* with *R. botryapithes*. *G. clavipes* occurs also on *J. communis*. Prof. Farlow also believes *G. Ellisii* to be a form of *R. transformans*, and *G. macropus* of *R. penicillata*.

Gymnosporangia and their Rœsteliæ.†—Mr. R. Thaxter, following up Prof. Farlow's paper, communicates the results of further studies on *Gymnosporangia* or cedar-apples and their relation to *Rœsteliæ*. The cycle of development in these fungi is first summarized, and a detailed account is given of the experiments by which the life-history was traced. An attempt is then made to elucidate the difficult problem of the relation of the various species of *Gymnosporangium* to their respective *Rœsteliæ*. The cycle verified by Mr. Thaxter was as follows:—At maturity, towards the close of spring, the cedar-apple consists of sporiferous masses growing from the distortions caused by the mycelium on the stem or leaves of the host. When moistened the masses expand and soften; the spores germinate and form hyphæ (promycelia); these form secondary spores or sporidia; these are carried by the wind from the juniper, cypress, &c., to certain Pomeæ, where they form *Rœsteliæ*. On the new host the sporidia germinate, entering the tissues and causing discoloration. Flask-shaped cavities (spermogonia) appear on the surface, and within these are formed minute bodies or spermatia of doubtful function. Opposite these, on the under side of the leaves, or in the same position with them in young shoots or fruits, cup-shaped æcidia are formed, and within these successive sets of spores surrounded by the membranous capsule or peridium. On the rupture of this the liberated spores are carried by the wind to cedars where they reproduce cedar-apples. No definite results were obtained for or against the theory that the spermatia are sexual and fertilize a female "trichogyne" which gives rise subsequently to the æcidium.

New Pythium.‡—Under the name *Pythium anguillulæ aceti*, Prof. R. Sadebeck describes a new species which attacks the vinegar-eel, kills it in a short time, and then developes luxuriantly in its dead body. In differs in no essential respect from the other species of the genus. The conidia and oogones are, however, produced contiguously and at nearly the same time, and the number of conidia is very large; they usually germinate directly, without the production of zoospores; the oogones and conidia are smaller than in other species of *Pythium*.

* Bot. Gazette, xi. (1886) p. 234. Cf. this Journal, 1881, p. 774.

† Amer. Acad. of Arts and Sci., Dec. 1886. Cf. Centralbl. f. Bacteriol. u. Parasitenkunde, i. (1887) pp. 429–34.

‡ SB. Gesell. Bot. Hamburg, Feb. 25, 1886. See Bot. Centralbl., xxix. (1887) p. 318.

Structure of Ravenelia.*—Mr. G. H. Parker finds *Ravenelia glandulæformis* abundantly on both sides of the leaves of *Tephrosia virginiana*, especially the under side. The hyphæ form a kind of hymenium in cavities beneath the epidermis, from which the uredospores are separated by abstriction, and escape through a perforation in the epidermis. Then appear the teleutospores, the mass of which fills the entire opening. Uredospores are formed only on the leaves, teleutospores also on the rachis and young parts of the stem. The teleutospores are very large, and consist of a stalk, on which is formed the so-called "cyst," and from this the mass of spores as an outer layer, the inner mass of cyst-cells having apparently no function except the dispersion of the spores. The spores are either uni- or bilocular. In *R. indica* the spores are unilocular, and each is not borne on its own cyst-cell, but, at the margin, each cyst-cell bears two or three spores. There are two types of teleutospore in the genus, one represented by *R. glandulæformis*, the other by *R. indica*.

Rhizoctonia.†—According to Prof. E. Rostrup, the mycelium of the *Rhizoctonia* of clover is essentially epiphytic. It is composed of creeping and branching hyphæ, with thickened septa, the thickness of which varies from 2–5 μ. On the part of the root which is coloured with this red mycelium numbers of blackish-red warts are to be found, formed of interlacing hyphæ which resemble unripe perithecia, without thecæ or spores. *Trifolium hybridum* often lives some time after the root has been destroyed by the fungus, putting out from the lower part of the stem numerous adventitious roots; and in this case the rose-coloured mycelium frequently extends above the soil upon the stem and the lower stipules. The tubercules, which by old writers were noted as one of the characteristics of *Rhizoctonia*, are few in number in the species parasitic on the clover. As for the warts, which, in the form of dots, cover the roots attacked, they have a diameter of 0·1 mm., and are placed very close together. Even under the Microscope they are a deep red. Several times, in the case of *hybridum*, the author found, on the attacked roots of the preceding autumn, warts developing pycnidia filled with numerous stylospores; on the red sclerotic tubercules of the roots of *Trifolium* and *Medicago* he also determined the presence of conidia. Perithecia and thecæ he failed to discover.

Rhopalomyces.‡—M. J. Costantin describes a new species of this genus, *Rhopalomyces nigripes*, growing on *Peziza arenaria*. He suggests the removal from the genus of all the species, such as *R. candidus*, with an uncoloured septated pedicel terminated by a sphere covered with hyaline spores; these he considers, should be relegated to *Œdocephalum*.

Sphæropsideæ, Melanconieæ, and Hyphomycetes.§—The 3rd and 4th vols. of Dr. P. A. Saccardo's 'Sylloge Fungorum' are occupied by a monograph of these three families. It having been shown that all hyphomycetous fungi are but stages of development of species belonging to a higher class, the conidial and pycnidial forms of many Pyrenomycetes and Discomycetes are described under the Hyphomycetes and Sphæropsideæ.

The Sphæropsideæ are divided into four forms, viz. (1) Sphærioideæ, with seven sections based on the character of the spores, viz. *Hyalosporæ*, *Phæosporæ*, *Phæodidymæ*, *Hyalodidymæ*, *Phragmosporæ*, *Dictyosporæ*, and *Scolecosporæ*; (2) Nectrioideæ, with two subcohorts, *Zythieæ*, with four

* Proc. Amer. Acad. Sci., xxii. (1886) pp. 205–18 (2 pls.).

† Overs. K. Danske Vid. Selsk., 1886, pp. 59–76 (2 pls.) and ix.–xiii. (French résumé).

‡ Bull. Soc. Bot. France, viii. (1886) pp. 489–93.

§ Saccardo, P. A., 'Sylloge Fungorum,' vols. iii. and iv., 1885, 1886.

corresponding sections based on the nature of the spores, and *Patellineæ;* (3) Leptostromaceæ, with four, and (4) Excipulaceæ, also with four corresponding sections. The Melanconieæ are divided into six sections, also founded on the characters of the spores. The Hyphomycetes are classed under four families, viz. (1) Mucedineæ, with five sections, *Amerosporæ*, *Didymosporæ*, *Phragmosporæ*, *Staurosporæ*, and *Helicosporæ;* (2) Dematieæ, with corresponding sections; (3) Stilbeæ, with two parallel series, *Hyalostilbeæ* and *Phæostilbeæ;* and (4) Tuberculariеæ, with two series, *Tuberculariеæ mucedineæ* and *dematieæ*.

New Fungoid Disease of Barley.*—Herr J. Eriksson describes a disease which is very destructive to barley in the neighbourhood of Stockholm, making its appearance as brown spots on the leaves, extending to the whole surface, preventing the production of ears, and finally killing the plant. He believes it to be produced by *Helminthosporium gramineum*.

New Disease in Corn.†—M. G. Passerini states that June 1883, M. Rignoni noticed, at Vigatto, that the corn stubble was covered with a cryptogamic growth. The parasite showed itself at the first node on the culm, and covered the sheath of the leaf and then the leaf itself with greyish spots, interspersed with black spots arranged in a longitudinal row in the parenchyma. A fresh attack of the same disease was noticed by the author in June 1886, at Torchiara, near Parma. This was investigated, and it is stated that the parasite which caused it is a new *Sphæria*. It has been taken as the type for a new genus, and has been called *Gibellina cerealis* Pass.

Structure and Life-History of Phytophthora infestans.‡—Prof. H. Marshall Ward, having been instructed by the Science and Art Department to prepare a series of drawings illustrating the structure and life-histories of certain parasitic fungi, here gives those which deal with the potato fungus; the remarks with which they are accompanied form a connected life-history.

Protophyta.

Lower Forms of Animal and Vegetable Life.§—M. P. A. Dangeard discusses the relationship towards one another of the Protozoa and the Chytridineæ, placing in the former class those organisms in which the food-materials are digested in the interior, in the latter those in which digestion takes place from the outside. Among the former he treats especially of the Vampyrelleæ, of variable form, the protoplasm of which never contains a nucleus, but a large number of reddish granulations; from the surface protrude a large number of filiform retractile pseudopodia. The food-material is sometimes swallowed for digestion; sometimes the cell-wall is pierced and the nutriment extracted. The Vampyrelleæ frequently divide during their period of activity; conjugation is rare; a variable number may unite into plasmodia. The sporangia are usually formed at the close of the period of activity; their cell-wall is composed of cellulose, and they give birth to zoospores. A production of cysts or resting forms also takes place when the conditions of life are unfavourable.

A number of species of *Vampyrella* are described, and it is proposed to sink in this genus Klein's *Monadopsis*. Nearly allied to the Vampyrelleæ are the heliozoarian Rhizopods, and descriptions are given of various species

* Bot. Sällsk. Stockholm, Feb. 17, 1886. See Bot. Centralbl., xxix. (1887) p. 91.
† Rev. Mycol., viii. (1886) pp. 177–8.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 413–25 (2 pls.).
§ Ann. Sci. Nat. (Bot.), iv. (1886) pp. 241–341 (4 pls.).

belonging to the genera *Nuclearia*, *Heterophrys*, and *Actinophrys*. Next come the zoosporous Monadineæ, of which the genera *Pseudospora*, *Barbetia* n. gen. (*Pseudospora Volvocis* Cnk.) and *Soretia* are treated. In this family should be placed *Chytridium destruens* Now.

The family most nearly allied to the Vampyrelleæ of an undoubtedly vegetable character are the Chytridineæ. Their close alliance to the Flagellata is confirmed by the discovery of a new genus of Chytridineæ carrying on a parasitic life within *Euglena viridis* and other Flagellata and Rhizopods, to which M. Dangeard gives the name *Sphærita*. It occurs in the form of large spherical masses which break up into zoospores which escape by the rupture of the wall of the host; each zoospore has a long strongly curved cilium placed in front. The author gives a series of reasons for concluding that these organisms cannot be endogenous reproductive germs of the host. Cysts are formed, but only very rarely. The nearest relationship of *Sphærita endogena* is with *Minutularia* (*Chytridium*) *destruens*, from which it differs in scarcely any other point but in its mode of nutrition.

Sphærita the author regards as the lowest member of the Chytridineæ; next to it come *Olpidium* and *Olpidiopsis*. *Olpidium apiculatum* Br. is the early stage of a *Rhizidium*; *O. zootocum* Br. is identical with *Catenaria Anguillulæ* Sorok., and should be placed among the Ancylisteæ. Then follow descriptions of the genera *Chytridium* and *Rhizidium*, with some of their species.

The Ancylisteæ are allied to the Chytridineæ through *Catenaria*; while *Ancylistes* leads, on the other hand, to the Peronosporeæ; *Pythium dichotomum* sp. n. appears to be a sexual phase of *Catenaria*. The cycle of development of *Ancylistes* is completed by the germination of the oospores.

Structure of Nostochineæ.*—In a general review of the structure of the Nostochineæ (Nostocaceæ, Rivulariaceæ, Oscillariaceæ, Scytonemaceæ, and Stigonemaceæ), Sig. A. Borzì states that the gelatinous sheath which invests each filament is reduced to very small dimensions in *Oscillaria*, and is entirely wanting in *Borzia*. The number of cells of which the hormogones consist is very variable, and may be reduced to two; in a few species only is it constant, viz. three in *Borzia trilocularis*, four in *Dactyloglœa prasina* sp. n., eight or sixteen in *Seguenzæa*, an undescribed genus of Stigonemaceæ. The hormogones are either perfectly straight or spiral, the former moving in a straight line, the latter describing with their apices a helicoid curve. This difference is accompanied by special biological peculiarities.

The straight homogones are always entirely destitute of any gelatinous sheath, as in *Lyngbya*, *Plectonema*, the Nostocaceæ, Scytonemaceæ, Rivulariaceæ, and Stigonemaceæ; while those that are spiral are clothed in a very thin transparent sheath, as in *Spirulina*, *Oscillaria*, and *Microcoleus*. The spiral torsion is especially strongly displayed in *Spirulina*. Spiral hormogones are specially characteristic of terrestrial species.

For the gelatinous substance of those cells which are in a resting condition, viz. spores and the constituent cells of hormogones, the author proposes the term *cyanophycin*. He states that, from a physical and chemical point of view, it is identical with the gelatinous substance in which the filaments themselves of the Nostochineæ are enveloped, and believes it to originate from the walls of the cells; it is probably a ternary substance allied to starch. The colouring of the cell-contents is not due to the presence of chromatophores; in *Nostoc ellipsosporum* he was unable to detect any nucleus, or only a very rudimentary one. A distinct connection from cell to cell by means of very fine threads of protoplasm or of cyano-

* Malpighia, i. (1886) pp. 74–83, 97–108, 145–60, 197–203 (1 pl.).

phycin can be demonstrated in many species of *Nostoc*. This intercommunication between the cells is always interrupted on the formation of heterocysts. During the transformation of ordinary cells into heterocysts, the walls become thicker, the cellulose-like substance collecting especially round the pores through which the strands pass, and eventually altogether closing them. The cells of the hormogones present the same peculiarity of structure.

Cells which are about to change into spores cease dividing transversely, and increase slightly in size; the contents become slightly darker in colour, and the gelification of the outer layers of the cell-wall ceases. The spore is the result of a true process of rejuvenescence, its cell-wall being formed, not from that of the old cell, but out of its contents. The mature spore possesses a distinct outer layer or exospore. The spores thus formed are true examples of cystidia.

Intercellular communication can be detected also in the Scytonemaceæ, Stigonemaceæ, and Rivulariaceæ, which present no difference, in other points of physiological importance, from the Nostocaceæ.

The Oscillariaceæ are conveniently divided into two groups, according as their movement is straight or spiral. Of the latter class *Oscillaria* may be regarded as the type. Contrary to the general statement, the author finds the filaments to be always invested in a delicate gelatinous sheath, which can be readily seen on treatment by alcohol. There is no sharp differentiation between the cell-wall and protoplasmic contents, the former being but a slightly differentiated peripheral portion of the latter. *Lyngbya* and *Microcoleus* present the same structure as *Oscillaria*. The helicoid motion of the filaments of *Oscillaria* is due to the axis of the filaments never being perfectly straight; the form and direction of the apical portion always differ from that of the main portion of the filament; and this apical portion is always protected by a kind of cap. In the case of those species which live associated in dense tufts, the motion is incessantly interrupted and altered in a variety of ways. The direction of the motion is strongly affected by light; but the author states that it is an error to suppose that this motion is constant at all periods of development of the filaments. It is confined to the reproductive period, when the colony is multiplying and extending its geographical area by the production of hormogones.

Heterocystous Nostocaceæ.*—Under this name, MM. E. Bornet and C. Flahault include all the Phycochromaceæ (Cyanophyceæ) which are reproduced by hormogones, and in which the cells are of two distinct kinds, ordinary vegetative cells;—and special cells, terminal hair-like cells or heterocysts, i. e. the Rivulariaceæ, Sirosiphonaceæ, Scytonemaceæ, and Nostocæ. The structure of these families is described in reference to the cells, the trichomes, the sheath, the heterocysts, the branching, the hormogones, and the spores.

The authors have been unable to detect the presence of a distinct nucleus in any one species. The cells attain their highest degree of differentiation in the Rivulariaceæ. They propose to limit the term "trichome" to the row of cells or masses of protoplasm, "filament" to the trichome with its gelatinous envelope. The gelatinous sheath, when thick, often consists of a system of lamellæ, crossed by transverse lines or folds, resulting from the extensibility of the integument of the cell, and the different capacities for gelification of its layers. Heterocysts occur in all the forms except a few species of Rivulariaceæ; they may be larger or smaller than the vegetative cells. In certain Rivulariaceæ (*Rivularia, Calo-*

* Ann. Sci. Nat. (Bot.), iii. (1886) pp. 323–81; iv. (1886) pp. 343–73.

thrix scopulorum, &c.) the authors find a kind of reproductive cells, which they call *conidia*, differing from ordinary spores in preserving the appearance of the vegetative cells, and multiplying indefinitely in the manner of *Chroococcus*.

The rest of the present instalment of the paper is occupied by a monograph of the Rivulariaceæ contained in the different French herbaria, which the authors divide into three subtribes, Leptochæteæ, Mastigotricheæ, and Rivularieæ, and ten genera, viz. *Leptochæte*, *Amphithrix*, *Calothrix*, *Dichothrix*, *Polythrix*, *Sacconema*, *Isactis*, *Rivularia*, *Glœotrichia*, and *Brachytrichia*. Of these *Polythrix* and *Isactis* are exclusively marine, *Glœotrichia* exclusively fresh-water; the other genera comprise both marine and fresh-water, including five brackish species. The total number of species described is 59, of which several are now described for the first time.

Effects of Solar Light on Bacillus anthracis.*—M. S. Arloing, who has already announced that spores of *Bacillus anthracis* sown in small quantities in a clear culture-solution are killed by two or three hours' exposure to the sunlight of June or July, notices the criticisms that have been made by MM. Nocard, Duclaux, and Strauss, and then gives an account of the later experiments which he has instituted. He finds that under conditions in which it is impossible for a mycelium to arise, the spores sown in the fluid are sterilized by the sun in a short time, which varies with the season of the year. The sun does destroy the spores placed in water, but it only does so after a longer period of time than is necessary to effect their death in a suitable fluid such as soup. Further investigations are necessary to determine the influence of liquid screens interposed between the spores and the sun; and to these the author intends to devote himself. What has been done is sufficient to give a hint as to the application of the results to hygiene; it would be well to expose to the rays of the sun, without any shelter, regions where the spores of micro-organisms have been deposited.

Bacillus Brassicæ.†—Dr. G. Pommer found in decoction of cabbage leaves, in addition to *Bacterium megatherium* and other small Bacteria, a Schizomycete characterized by mycelia in its vegetative condition, and which is propagated by endogenous spores inclosed, after germination, in a distinct spore-case.

The vegetative forms derived from cultivation show more or less distinct markings along the course of the mycelia, the thickness of which is 0·00091–0·0012 mm. The sparseness or closeness of the sowing and the consistence of the nutritive medium appeared to exert some influence on the form of the mycelium. If thinly sown, straight or wavy lines of threads without loss of continuity are developed; but when more closely packed, the lines become more curved and spiral. Cultivation on agar-agar produced straight bundles of filaments, while within the medium tortuous masses of straight, wavy, and short threads were formed. Deprivation of air was found to be a principal cause of involution, and occurred in the worn out and spore-forming filaments. In the latter case a complete disappearance of the protoplasm took place; in others, changes occurred in the plasma, together with swelling up of the membrane. Spores originate only with access of air, and at first appear as greyish balls. Fully formed spores are oval, being about 0·0009 mm. broad, and from 0·0012–0·0015 mm. long. At a temperature of 33° C. they are formed in sixteen to twenty-four hours; at ordinary temperature, in double the time. In a short joint there is one spore; in the larger ones sometimes two, and their position is usually terminal. As the spore germinates, it increases

* Comptes Rendus, civ. (1887) pp. 701–3.
† MT. Bot. Inst. Graz, i. (1886) pp. 93–112.

considerably in size, and after rupture of the membrane a rod-like form appears. This happens at 33° C. in 1¼–1½ hours. The germs grow in a straight or curved direction with terminal increase, but with very variable degrees of rapidity. In no stage of development was there any evidence of motility. White mice injected with or fed on the spores were unaffected. For this Schizomycete the author has proposed the name *Bacillus Brassicæ.*

Bacterium of Wheat Ensilage.*—In an examination of wheat ensilage, Dr. O. Katz found three kinds of bacterium and two kinds of mould. One peculiar bacterium is described, having the form of *Streptococcus.* The bacteria were cultivated on gelatin plates, and this particular form showed itself as yellowish-white colonies amongst the others, the outline being crenate; and as growth proceeds, they form white patches, the centre of which is depressed. The chains of micrococcus-like forms stain intensely with methylene-blue, &c. Cultivated in test-tubes, liquefaction takes place in a funnel-like manner around the needle path, being especially active on the surface. Ultimately the whole is liquefied. The bacterium readily grows on sterilized potato. The growth of the *Streptococcus* is accompanied by a sour smell.

History and Biology of Pear Blight.†—Mr. J. C. Arthur enumerates the various theories and hypotheses that have been put forward as to the nature of pear blight. In 1877 Professor Burrill first observed the bacteria of blight. In 1882 he characterized the organism under the name of *Micrococcus amylovorus.* The form of this species of bacterium is very constant under all conditions. The single cells are from oval to roundish-ovoid, and only vary by slight changes in the ratio between their length and breadth; being from 1 to 1¼ μ long, by 1/2 to 3/4 μ broad, and quite colourless. For the most part they exist as single independent cells, but may often be found in pairs, especially when still multiplying, and in rare instances are united into a series of four or even more, but never extend into chains.

By far the most characteristic feature of the life-history of *M. amylovorus* is the formation of zooglœa-colonies. These have never been observed in the tissues of the tree, under any conditions, or in or upon any sort of solid medium, but they occur with much regularity in fluid cultures, when placed under favourable conditions for rapid growth. The range of substances which may serve as culture media is very wide; that which on the whole has proved most satisfactory in an infusion of potato. This is prepared by digesting a pared potato in three or four times its bulk of water over a water-bath for a couple of hours. If the heat is allowed to rise much above 70° C., the starch is gelatinized, and it is only with difficulty that the solution can be filtered. Another equally good culture fluid is made by treating corn (maize) meal in a similar manner. The solution is colourless, but it is apt to throw down a troublesome sediment. An infusion of hay gave a nearly normal growth of blight bacteria, but the cells were considerably more refractive than usual.

As to its behaviour towards staining fluids, the most successful results have been obtained with an aqueous solution of Bismarck-brown, especially in cover-glass preparations. What chemical changes are brought about by its activity in the plant cannot be definitely stated, further than to say that a mucilage or gum, which is soluble in water, is produced in abundance, with the disengagement of carbon dioxide.

Bacterium of rotten Grapes.‡—Sig. L. Savastano dissents from the view that the disease of the grape which has been so wide-spread during recent

* Proc. Linn. Soc. N. S. Wales, i. (1886) pp. 925–8 (1 pl.).
† Proc. Acad. Nat. Sci. Philad., 1886, pp. 322–41.
‡ Malpighia, i. (1886) pp. 175–83. See this Journal, *ante*, p. 129.

years is due to *Phoma uvicola*, to *Peronospora*, or to "black rot." Whether the rottenness be dry or moist, he was able to detect, with sufficient enlargement (600 diams.), the invariable presence of a special bacterium, for which, however, he does not propose any specific name, but was able to cultivate it on peptonized and sterilized gelatin. The difference between dry and wet decay he attributes to the state of the berry and of the atmosphere, the former appearing especially on green, the latter on ripe grapes. The leaves of the grape-vine have been described by Viala and Ravaz as being also subject to the attacks of a bacterium, which is probably identical with that of the berry, though this has not been demonstrated.

Destruction of Pathogenic Schizomycetes in the organism.*—Herr Ribbert states that after the injection of small quantities of spores rabbits do not die but remain healthy. From the examination of the organs at various intervals after injection, it was found that a regular germination of the spores did not occur. After six hours they were found, especially in the liver, to be surrounded by leucocytes. The collection of white corpuscles, among which the spores were destroyed, in some few days led to the formation of small nodules, dilatation of the capillaries, and compression of the liver cells. With the death of the fungi the leucocytes disappeared, the liver cells recovered frequently with the formation of giant cells, which often contained spore-remains. In the lungs, also, giant cells were formed from the endothelia, and these also took up the fungi. In both organs the spores only came to an imperfect germination like a fine radiation, their regular development being hindered by the protoplasmic investment chiefly produced by the leucocytes.

Lepra Bacilli.†—Dr. P. Guttman, from frequent examinations of a case of lepra occurring in a girl twelve and a half years of age, was able to confirm the observations of previous writers. Unstained bacilli examined in distilled water, with 1/12 oil-immersion, showed lively movements both when within the cells and when lying free without. When stained the bacilli were found to behave as previously reported by Neisser and Koch. The author is of opinion that lepra bacilli stain more quickly than those of tubercle, and as a point in the differential diagnosis of these two from cover-glass preparations, he remarks that lepra bacilli are very often found within the cells, while those of tubercle are rarely or never seen in similar situations.

Micro-parasite of Variola.‡—Dr. A. Marotta has found that there constantly exists, in the lymph of the variola vesicle which has not yet suppurated, a specific micrococcus. This occurs as tetrads. After suppuration other cocci appear; these are, for the most part, the *Micrococcus albus*, which greatly resembles the micro-parasite described by other authors.

This micrococcus (tetrad) is easily cultivated in nutritive gelatin and in agar rendered alkaline, in coagulated ox-serum, on boiled egg, but not on potato. It seems to flourish best on decidedly alkaline media. The colonies are of an orange-yellow colour, thick, and raised above the level of the nutritive medium. As inoculations made on calves, even with the seventh generation of the culture, produced pustules perfectly identical with those of vaccinia, Dr. Marotta draws the conclusion that this tetrad form is the specific micrococcus of variola. Inoculations of dogs gave only negative results. As subcutaneous injections did not produce any specific lesion, the inference is drawn that the tetrad coccus has nothing in common with pyogenic cocci.

* Bot. Centralbl., xxviii. (1886) p. 396. (Ber. 59 Versamml. Deutsch. Naturf. u. Aerzte, 1886.)

† Berl. Klin. Wochenschr, 1885, No. 6.

‡ Atti R. Accad. Lincei—Rend., ii. (1886) pp. 246–7.

Micro-organisms in the Atmosphere.*—Dr. P. F. Frankland describes a new method by means of which he claims that the estimation of organisms in the air can be more accurately obtained.

A known volume of air is aspirated through a glass tube containing two sterile plugs, the first of which is more pervious than the other. The two plugs are then transferred to two flasks, each containing melted sterile gelatin-peptone, and plugged with sterile cotton wool. The plug is carefully agitated, and when it has become disintegrated and mixed with the gelatin, the latter is congealed, so as to form an even film over the inner surface of the flask. The flasks are incubated at a temperature of 22° C., and after four or five days the colonies derived from the organisms contained in the plug make their appearance.

The process possesses all the advantages of a solid medium. The results are not affected by aerial currents. The collection of an adequate quantity of air takes but little time, so that a much larger volume can be examined than by Hesse's method. The apparatus, being very simple, can be used where there is no special laboratory.

Distribution of Micro-organisms in the Air.†—Dr. P. F. Frankland and Mr. T. G. Hart add to their previous experiments with Hesse's apparatus on the prevalence of micro-organisms in the air. The number (per 10 litres of air) varies greatly with the season, e. g. in January, 4, and in August, 105 were found to be present. Experiments in crowded rooms also show the enormous increase in number of micro-organisms; thus in the library of the Royal Society, during a conversazione, as many as 432 per 10 litres were found. By exposing dishes filled with nutrient gelatin, the authors were able roughly to estimate the number of micro-organisms falling on a given horizontal surface.

Micro-organisms of the Soil.‡—Herr B. Frank has examined the living organisms found in various samples of soil taken from localities where there seemed no possibility of their being influenced by human agency. Among the forms found in most of the cultures, but not without exception, were a *Cephalosporium*, a simple *Botrytis*-form, a *Torula*-form, an *Oïdium*, in one case a *Mucor*, and a *Torula*-form with nearly spherical bud-cells. Invariably there was also present, in all the cultures, a Schizomycete, presenting, in all the samples, a similar succession of forms of development. About the second day it made its appearance as a *Leptothrix*, causing the gelatin to deliquesce. The threads collect into an interwoven mass, and then break up into the second or *Bacillus*-form, which increase rapidly or finally divide again by bipartition into the third or *Bacterium*-form of very short rods or oval cells. Within the cells are formed shortly oval, strongly refringent spores, usually one or two near the end of each rod; and these close the series of development. The rods become disorganized and their membrane gelatinized, the spores becoming thus collected into zoogloea-like masses, from which they again germinate in the form of rods. The different forms may be motionless or may display various degrees of motility. The bacilli are frequently curved in a comma-form. This universally distributed microbe of the soil Frank proposes to call, according to its stage of development, *Leptothrix terrigena*, *Bacillus terrigenus*, or *Bacterium terrigenum*. Its closest resemblances are with the hay-bacterium and anthrax.

The best nutrient materials for this microbe of the soil are gelatin and decoction of plums. Pure cultures exhibited no tendency to nitrification, i. e. to the conversion of ammonia-salts into nitrites or nitrates; and the

* Proc. Roy. Soc., xli. (1886) pp. 243–6. † Ibid., pp. 446–7.
‡ Ber. Deutsch. Bot. Gesell., iv. (1886), Gen. Versamml., pp. cviii.–cxviii.

same was the case also with the Hyphomycetes. The author concludes that, although it is possible that, under certain conditions, bacteria may be able to oxidize ammonia, yet the nitrification which goes on in the soil is mainly due to inorganic factors, the power of the soil in this respect being possibly analogous to that of spongy platinum.

Bacteria in the Soil.*—Herr L. Adametz has examined the bacteria and other low fungoid organisms present in the soil, and finds them almost identical, whether the soil be sandy or loamy. Of Schizomycetes he finds *Micrococcus candidus*, *M. luteus*, *M. aurantiacus*, *Diplococcus luteus*, *Bacterium Lineola*, *B. Termo*, *Bacillus subtilis*, *B. butyricus*, *Vibrio Rugula*, and two new bacteria, one of which produces a blue-green fluorescent pigment, and a new bacillus. Of Saccharomycetes there were found *Saccharomyces glutinis*, *Monilia candida*, and red and white torulose cells; of moulds, *Penicillium glaucum*, *Mucor Mucedo*, *M. racemosus*, *M. stolonifer*, *Aspergillus glaucus*, and *Oïdium lactis*. The number of Schizomycetes was estimated by Thoma's apparatus as varying between 400,000 and 500,000 per gramme of soil.

The author was unable to affirm the presence of a distinct bacterium with the power of oxidizing considerable quantities of ammonia into nitric acid; on the other hand he found not unfrequently that they caused a production of ammonia by reduction of nitrates. He regards the function of the moulds, which frequently hibernate in the soil, to be the decomposition of carbohydrates without the production of gases with an offensive smell.

Bacteria in Drinking-water.†—Mr. M. Bolton, in his research, used Koch's plate-culture method, as he found it to be superior to the Fol-Dunant procedure.

From an examination of different waters (spring, pond, &c.), he found, in agreement with Cramer and Leone, that a significant increase of bacteria takes place at first, but that this increase is succeeded, in three to ten days, by a slowly augmenting decrease. He further found that the quality of the water in respect to its organic and inorganic contents was without influence on the increase of water bacteria. A temperature of 1° C. was marked by a diminution in the number of bacteria, while temperatures of 6°, 15°, and 22° C., was followed by a proportional increase. The influence of hydrogen and carbonic acid gases (effected by means of the apparatus employed by Liborius) showed that the former gas was little or no hindrance to development, while CO_2 diminished the developmental activity, or even destroyed it.

The question whether pathogenic bacteria such as *B. anthracis*, *Staphylococcus aureus*, *M. tetragonus*, and *B. entericus*, were capable of propagating themselves in water, was decided in the negative. The disappearance of these organisms showed itself more quickly at higher temperatures (35° C.) than at lower ones (20° C.), and was further dependent on their capacity for specific resistance, and especially whether they were sporiferous or not. The quality of the water made considerable difference; for if nutrient material such as meat infusion were in small quantity, typhoid and cholera bacilli began to multiply.

Bacteria in Water.‡—Dr. G. Wolffhügel and Dr. O. Riedel, from their experiments, arrived at the same conclusions with regard to pathogenic bacteria as Mr. Bolton. They differ, however, from him as to the non-pathogenic forms, inasmuch as their experiments showed that typhoid and anthrax bacilli increased in water when temperature conditions were

* Adametz, L., 'Unters. üb. d. niederen Pilze d. Ackerkrume,' 78 pp. and 2 pls., Leipzig, 1886.

† Zeitschr. f. Hygiene, i. (1886) p. 75.

‡ Arbeit. K. Gesundheitsamte, 1886, Heft 2. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 417-20.

favourable. Cholera bacilli in unsterilized water were found to disappear in a few days, but in sterilized water an initial diminution was followed by a copious increase. The authors also noted that typhoid and cholera bacilli were capable of luxuriant growth in milk.

The method adopted was more minute and fractional than that of Bolton. Inoculations were at first made with platinum wire, and afterwards by means of a capillary pipette, divided into 1/500 cc. If after using 1/500 cc. too many germs appeared on the plate, 5/500 cc. of the infected water was diluted with 200 cc. of sterilized distilled water, and then 5/500 cc. of this fluid used, so that only 5/100,000 cc. of the germ water were sown.

Bacteriological Examination of Water.*—Dr. O. Katz examined the tap-water of Sydney by means of Koch's gelatin plate method. The five forms noted are described as *Bacterium* A, B, C, D, and E. The appearance of the colonies on gelatin plate, in test-tube of gelatin, and on oblique surface of agar-agar, is described and figured. The author notes the greater number of bacteria in the water after rain.

Bacteria in Ice.†—Dr. T. M. Prudden in a series of thirty-two analyses of Croton water found the lowest number of living bacteria to be 57 per cm., the highest 1950; the average 243. His experiments to test the effects of freezing on bacteria, showed that after prolonged freezing a considerable number of the typhoid bacilli remained alive. His method was as follows. Into sterilized test-tubes was put sterilized water mixed with a small quantity of a pure cultivation, the number of bacteria in one cubic centimetre of water having been previously determined. The tubes were then heated to from 14°–30° F. Six species of bacteria were experimented on. (1) *Bacillus prodigiosus;* (2) a short bacillus found in Hudson river water; (3) a slender bacillus common in Croton water; (4) *Staphylococcus pyogenes aureus*; (5) a short bacillus from ice, which is called "a fluorescent bacil lus" from its appearance in gelatin; (6) typhoid bacillus. In the case of *B. prodigiosus*, 6300 in a c.cm. before freezing diminished in four days after freezing to 2970; in 37 days to 22, and in 51 days to none. *Staphylococcus*, which were countless before, diminished after freezing for 18 days to 224,598, to 49,280 in 66 days. The number of typhoid bacilli, countless before freezing, was 1,019,403 after 11 days, 336,457 in 27 days, 89,796 in 42, and 7348 in 103 days.

The general conclusions at which Dr. Prudden arrived, are that analysis of water and ice gives evidence of bacteria, many of which are the originators of disease, but the study is too much in its infancy for a definite opinion to be given as to whether the ice or water be suitable or not for drinking purposes, &c.; that the freezing process only partially purifies, the grosser impurities only being removed, and the bacteria remaining to a considerable extent unaffected; that the different species of bacteria show different degrees of vulnerability to cold, the bacilli of enteric fever and the bacteria of suppuration being capable of standing prolonged exposure to a low temperature; that in natural waters there may be a purification up to 90 per cent.; that while filtration destroys noxious and harmless bacteria to an equal extent, the freezing process is more destructive to innocuous than to pathogenic organisms; that there is a much greater number of bacteria in snow-ice and in bubbly ice than in transparent ice, which if taken from certain lakes and ponds is very pure; that the average number of bacteria in ice from all sources is much greater than the standard for ordinary water.

* Proc. Linn. Soc. N. S. Wales, i. (1886) pp. 907–23 (2 pls.).
† Med. Record, 1887, March 26 and April 2, 61 pp.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Burch's Perspective Microscope.†—In 1874, Mr. G. J. Burch "discovered a form of Microscope giving constant magnification along the optic axis, so that the objects were shown by it in microscopic perspective."

By writing $(f_1 + f_2 + \mathrm{H})$ for the distance between two thin lenses, he obtained for the formula of the system

$$\frac{f_2(f_2 + \mathrm{H})u - f_1 f_2(f_1 + f_2 + \mathrm{H})}{\mathrm{H}u - f_1(f_1 + \mathrm{H})} = v;$$

u being the distance from the object to the first lens, and v that from the second lens to the image.

Putting $\mathrm{H} = 0$ in this equation, three things result:—

1. du/dv, which represent the longitudinal magnification, becomes constant, namely—$(f_2/f_1)^2$;

2. The lateral or angular magnification, f_2/f_1, is also constant;

3. A picture of an object so magnified, drawn with the camera lucida, when viewed from a distance f_2/f_1 times less than that at which it was drawn, has the perspective belonging to an object magnified $(f_2/f_1)^2$ times.

The distance at which the eye must be placed is great, but may be reduced by employing three lenses, the distance between the first and second being $(f_1 + f_2 + f_2/m)$, and that between the second and third $(f_2 + f_3 + mf_2)$.

If the lenses are nearly but not quite in the afocal position, greater power and a wider field may be obtained; but it is at the expense of the penetration, which may, however, with advantage be limited to the thickness of the object. The instrument offers great advantages for artistic purposes, but lenses or mirrors of specially wide angle are needed for the farther development of the invention.

The optical conditions of a system of two thin lenses at varying distance apart are shown by diagrams.

In diagram 1 the u and v of the formula employed are set off as abscissæ and ordinates, and the curves (which are rectangular hyperbolas) drawn for several values of H. In the afocal position of the lenses, the curve degrades into a line which is a tangent to all the hyperbolas at the point (f_1, f_2). The locus of vertices and locus of centres of these curves being straight lines, and the hyperbolas all touching the point (f_1, f_2), it is shown that the principal foci, principal points, and equivalent focal length for any given position of the lenses, can be found by rule and compasses, without drawing the curve.

In diagram 2 the actual position of the lenses, their principal foci, separate and combined, and the principal points, positive and negative (answering to the vertices of the curves in diagram 1), are plotted down as abscissæ, the values of H on an enlarged scale being taken as ordinates.

Diagram 3 shows the same for two lenses of equal focal length.

Comparison of these two diagrams suggests the employment of the term "pseudo-principal points" for those positions at which the magnitude

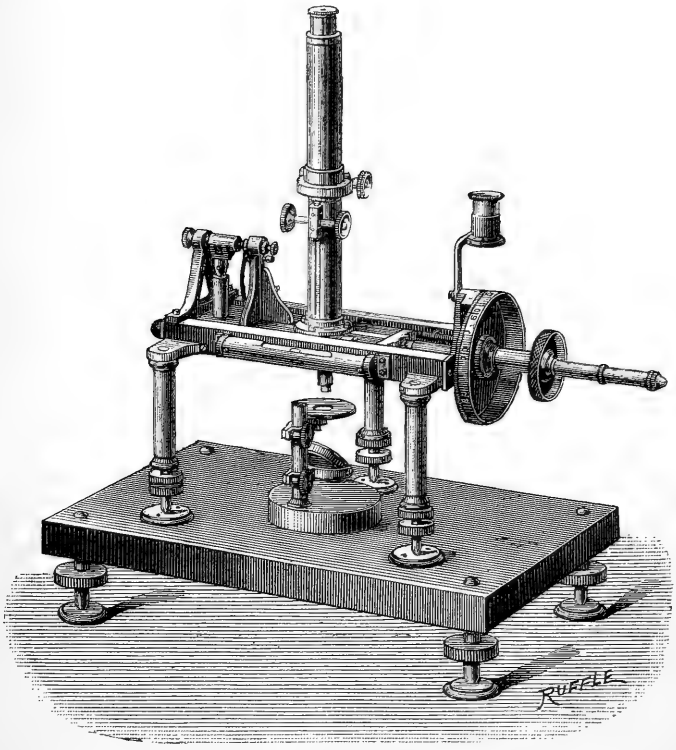
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photo-micrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Proc. Roy. Soc., xlii. (1887) pp. 49–50. See also this Journal, *ante*, p. 288.

of the image is in the constant ratio f_2/f_1 to that of the object for every value of H, inasmuch as the distance from these to the principal points gives the measure of the "penetration" of the system.

Campbell's Micrometer-Microscope.—This (fig. 96) was originally devised by Sir Archibald Campbell for measuring photographs of spectra;

FIG. 96.



it has since been improved for measuring diffraction gratings, and special means have been added for recording end-measurements of standard gauges by utilizing electrical contacts. It is made by Mr. A. Hilger.

It consists of a horizontal metal frame, in which a Microscope is applied to slide over a space of $5\frac{1}{2}$ in. actuated by a micrometer-screw. The frame is supported on three pillars, with adjusting screws for levelling with conical ends fitting in V-slots converging to a common centre, and applied on a substantial iron base-plate standing on adjustable screws, also for levelling.

The micrometer-screw has a pitch of 100 threads to the inch; the drum-head connected with the screw is divided into 100 parts on the edge, and by means of a vernier, direct readings can be taken up to 1/100,000 of an inch. For registering entire revolutions of the screw a fixed scale corresponding with the pitch of the screw is engraved on one side of the frame, and an index-pointer travelling with the Microscope gives the readings.

The diffraction gratings, &c., are carried on an adjustable stage with mirror that can be placed as required on the base-plate under the Microscope.

For standard end-measurements, where the difficulty is to determine the precise points of contact, the object is placed in a double V-carrier, one end touching a fixed electrical contact-point, the other end is then presented towards a travelling contact-point, actuated by the micrometer-screw, and the contact is shown by the deflection of a delicate galvanometer needle to an estimated accuracy of about 1/1,000,000 in. For registering temperatures, a thermometer is attached to the micrometer frame.

In practice the stage-plate on which the object is placed is first levelled by means of a spirit-level, then the tripod of the micrometer-frame is adjusted in the V-slots on the base-plate and accurately levelled, for which purpose spirit-levels are applied to the frame at right angles.

For high-power work the Microscope is furnished with Mr. Hilger's tangent-screw fine-adjustment, in which the motion is unusually slow, and which is described *infra*, p. 461.

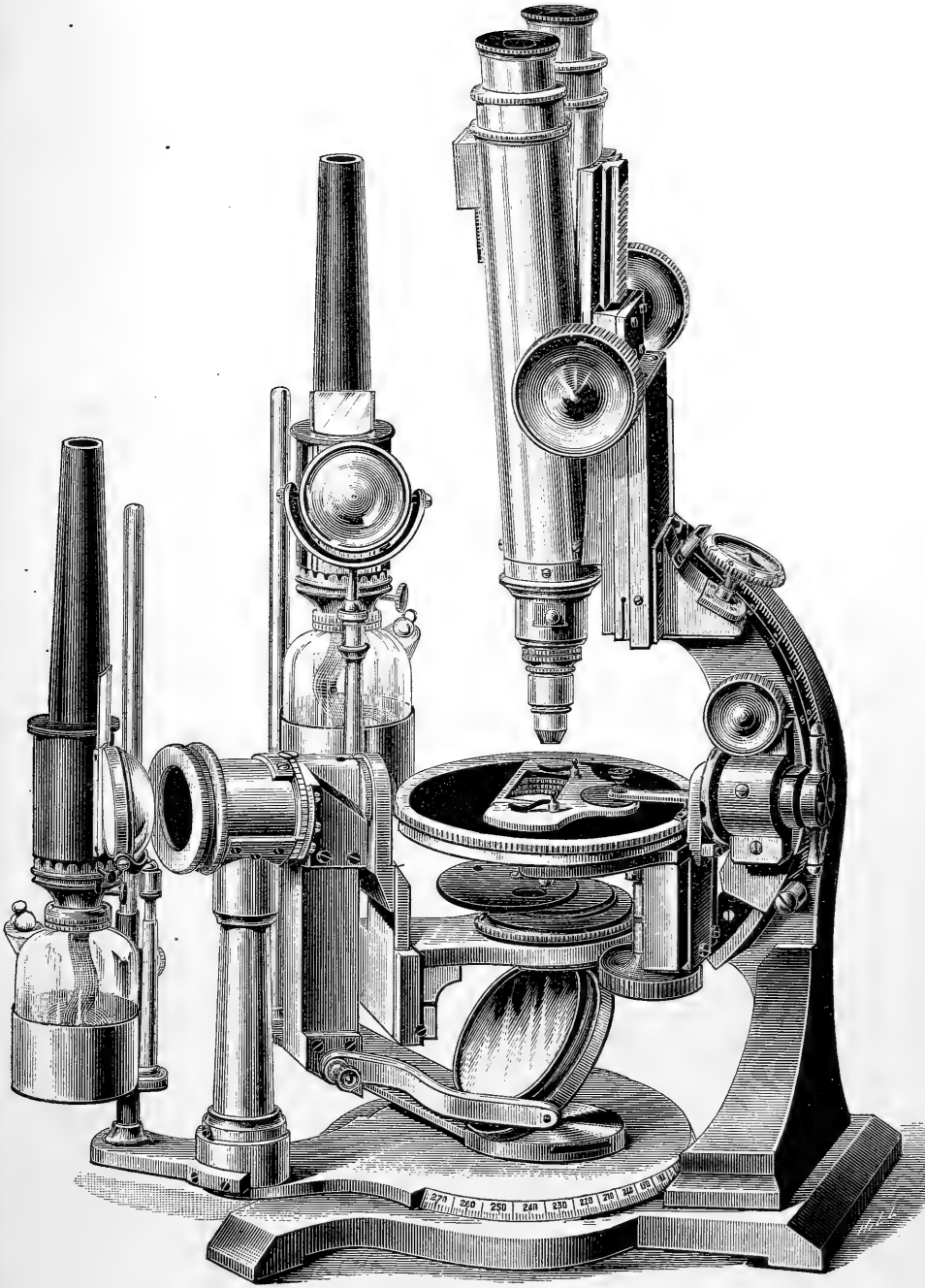
Watson-Draper Microscope.—This Microscope (Plate IX.) made by Messrs. Watson & Sons, after the designs of Mr. E. T. Draper, is an elaboration of the instrument suggested by Mr. E. Crossley.* The following description is furnished by Messrs. Watson:—

The idea in arranging it is, that when the object is on the stage, either it may be made to rotate in any direction, horizontal or vertical, round a fixed beam of light, without the light ever leaving the object, or the stage may be kept fixed while the light is revolving round it in any direction, horizontal or vertical; always, however, remaining upon the object. Of course to do this exactly it is absolutely necessary that the object should be precisely in the centre of all the circles in which the various parts of the instrument are revolving, and to enable this to be done with the utmost precision, there is an adjustment to the stage by means of a micrometer-thread screw below, to raise or lower it according to the requirements of different thicknesses of objects.

The body is mounted on an extremely solid pillar carrying a quadrant of a circle, and in this it may be placed in any position from the horizontal to the vertical, and as the stage is connected and moves with the body, and as this arc of a circle is struck from a radius, the centre of which would be the object on the stage, it follows that when light is thrown from directly underneath the object, by inclining the Microscope through this arc and without touching the mirror, the light becomes more and more oblique, till it arrives at that point where it is impossible for it to enter the objective. Again, the stage being a concentric rotating one, allows the object to be moved horizontally round the same fixed light. The two motions therefore are used when it is desired to place the object in any position with regard to a ray of light.

For those objects, however, which could not be conveniently moved, there is another arrangement for keeping the object stationary, while the light is thrown upon it from any desired angle. This is done by using Mr. Crossley's arrangement of a train of prisms transmitting the light on to the mirror and rotating on an axis in the same plane with the object on the stage. The prisms have also an additional movement which Mr. Crossley's arrangement has not, viz. the pillar supporting them is fixed upon a horizontal rotating base-plate so that by the movement of the base-plate, combined with the swinging motion of the prisms, the light may be thrown through them upon the object from any direction, horizontal or vertical. A lamp is fixed permanently to the pillar carrying the prisms, which moves with it in whatever direction it is placed. There is also a

* See this Journal, 1881, p. 653.



Watson-Draper Microscope.

second lamp supplied for illuminating opaque objects from both sides of the instrument, so as to avoid the influence of shadows. The whole of the circles in which the various parts of the instrument revolve are graduated to degrees so that the observer may be able to tell the angle at which any effect has been produced in order that it may be at once obtained again.

The substage and mirror are attached to the prism-box, and move with it. The mirror can also be detached and applied to the centre of the base.

The stage can be raised and lowered to compensate for the different thicknesses of the slide.

Universal Projection Apparatus for Mineralogical Purposes.* — Dr. F. J. P. van Calker's apparatus is announced under the title of "Universal projection apparatus for the representation of microscopical images of thin slices of rocks with and without polarization, of the phenomena of thick and thin crystal plates in parallel and convergent polarized light, of tension phenomena, of the difference between parallel and oblique extinction, the phenomena of pleochroism and microchemical reactions." It is, however, nothing more than a stand with a brass ring, through which crystallographic, optical, and microscopical apparatus are pushed.

Culpeper's Simple and Compound Microscopes (Wilson's form).—The Microscope shown in fig. 97 (simple) and fig. 98 (compound) would appear

FIG. 97.

to have escaped the notice of the writers who have treated of the history of the construction until quite recently.† It was designed and made by Edmund Culpeper whose name is generally known in connection with the

* Zeitschr. f. Krystallogr., xii. (1886) pp. 55–8 (1 pl.).

† Society of Arts Cantor Lectures on the Microscope, by J. Mayall, junr. (reprint in collected form), 1886, pp. 34–5 (2 figs.).

vertical tripod form of Microscope that was so popular from 1738 down to the end of the century. From the fact that no example which we have seen of this instrument was furnished with a Lieberkühn, we think it was probably constructed before 1738.

In fig. 97 the peculiarities are (1) the application of a ball-and-socket inclining movement on a pillar and tripod, to Wilson's "Screw-barrel" Microscope, (2) the addition of an articulated arm to carry a condensing lens, for opaque objects (as in fig. 97), or a plane mirror (as in fig. 98). For opaque objects the lens was removed from the body-tube and a disc having a pivoted arm terminating in a ring substituted. A low-power lens in a horn mount was then screwed in the ring and was thus held at some distance from the instrument so that the object could be properly illuminated.

In fig. 98 the compound body of ivory with draw-tube is shown, also the

Fig. 98.

accessory apparatus. On the left are four simple lenses in disc-mounts; the ivory handle for the "Wilson," when unscrewed from the ball-and-socket, having a screw-box at the end for discs of talc and rings; the forceps-carrier; a diaphragm for the condenser (which is a bi-convex lens in a cell at the lower end of the "Wilson"); hinged animalcule cage with four concave discs of glass, mounted in apertures in a plate on which a similar plate with four corresponding apertures and plane discs is hinged to open or close; condensing lens for opaque objects; carrier with horizontal rotating and vertical pivot movements for the low-power lens in horn cell,

&c.; glass tube for aquatic objects, and forceps. In later constructions Culpeper applied the mirror to one of the feet in a line with the optic axis.

Hilger's Tangent-screw Fine-adjustment. — This fine-adjustment, devised by Mr. A. Hilger, is in principle a direct-action screw, controlled by a worm-wheel and tangent-screw. The mechanism is shown in figs. 99, 100, and 101, and it is applied in the middle of the body-tube.

A is a tangent-screw, actuated by the milled head A′, gearing with a worm-wheel collar B B, having an internal thread by which it engages the screw C C at the upper end of a tube sliding within the body-tube D and carrying the objective at the lower end, the metal stop E preventing

Fig. 99.

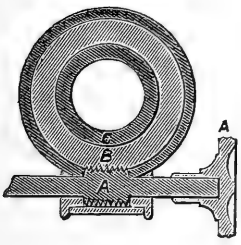


Fig. 100.

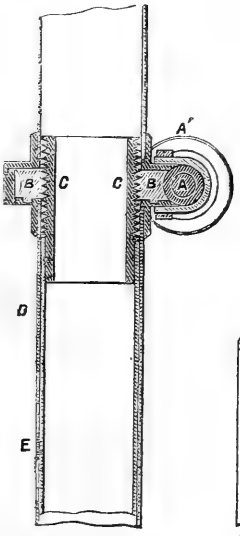
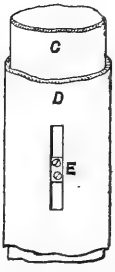


Fig. 101.



lateral movement. B B is fitted in bearings so as to rotate only. The rotation of A moves BB slowly round, causing C C to travel up or down as required in focusing.

Beck & Co.'s Microscopes.

["Apropos of the statement in the December number, that Zeiss had recently issued his 10,000th Microscope, we learn that Beck & Co., London, have manufactured over 14,000."]

The Microscope, VII. (1887) p. 93.

Dippel, L.—A. Nachet's grosses Mikroskop No. 1 und dessen Objectivform. (A. Nachet's large Microscope No. 1, and his Objectives.)

[Description of the Microscope described in this Journal, 1886, p. 837.]

Zeitschr. f. Wiss. Mikr., III. (1886) pp. 457–60 (1 fig.).

Dissecting Microscope, how to make a simple.

[Made out of a crayon box (or a similar one having a sliding lid) with corks, a rod, wire, &c.]

Engl. Mech., XLV. (1887) p. 96, from *N. Gleaner*.

Houzeau, J. C.—Microscope et Télescope.

Bull. Soc. Belg. Micr., XIII. (1887) pp. 90–110.

LATTEUX, P.—**Manuel de Technique Microscopique.** (Manual of Microscopical Technique.)

[Cf. *infra*, β (1). In addition to Technique, it contains chapters on Simple and Compound Microscopes, Accessories, Test Objects, Micrometry, Drawing, and Photomicrography.]

3rd ed., xvi. and 820 pp. (385 figs. and 1 pl.), 8vo, Paris, 1887.

Powell's (T.) Microscope and Appendages "made out of odd materials of various kinds." (Mr. Powell is a shoemaker.)

Proc. Lit. and Phil. Soc. Liverpool, No. XXXIX. (1885) p. xlviii.

(2) Eye-pieces and Objectives.

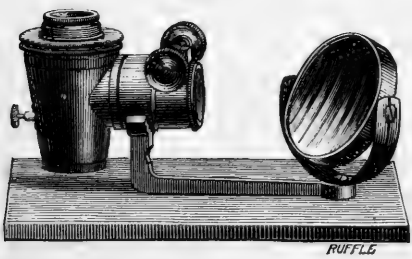
Apochromatic Objectives.*—Dr. M. D. Ewell has examined a Zeiss apochromatic objective, 1/12 in. N.A. 1·40 (with eye-pieces), made from the new optical glass. By oblique light he considers it is a well-corrected objective, but no better than first-class American objectives, except that the images have hardly any perceptible colour. With axial illumination, however, using an Abbe condenser of N.A. 1·40, with no stops or diaphragms whatever, the real superiority of the glass becomes apparent. "I have never before seen so clear and perfect a picture under similar conditions; and it is clearly apparent that the corrections are approximately perfect up to the extreme limit of its aperture. It is not difficult with such axial illumination to resolve a Möller Probe-Platte from end to end, and the images are practically colourless. In the present state of our knowledge, this objective certainly leaves nothing to be desired. The working distance is large, about 1/100 in., and the so-called searcher eye-pieces make even as high a power as a 1/12 very convenient in use. I do not assume to speak for any one but myself; but such, as it seems to me, must be the judgment of any unbiassed observer. For the practical worker with axial illumination, it seems to me that the apochromatic objective is destined to become the objective of the future."

Double Objectives with a common field of view.†—These (made by Herr H. Westien) consist of two lenses or lens-systems, which having been ground away at the edges on one side are placed so near and under such an angle to each other that their optic axes coincide with the axes of the eyes; when this is the case the two fields of view appear united into a single one.

(3) Illuminating and other Apparatus.

Hilger's Opaque Illuminator.—For the illumination of opaque objects to be viewed with Campbell's Micrometer-Microscope, Mr. A. Hilger has devised the apparatus shown in fig. 102, which is a modification of Prof. H. L. Smith's vertical illuminator.

FIG. 102.



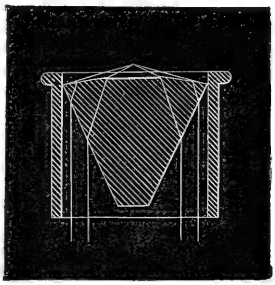
The reflector is concave, of speculum metal, of oval shape, and having a central aperture, through which the rays pass from the objective to the eye-piece. It is mounted in a conical tube, inclined normally 45° to the optic axis, and by means of an adjusting screw this angle may be altered a few degrees, so that the object may be illuminated from one side only if required. A system of condensing lenses with rack-work is applied to direct the light from the external mirror to the speculum, whence it is reflected through the objective and condensed upon the object.

* The Microscope, vii. (1887) p. 63.

† Central-Ztg. f. Opt. u. Mech., viii. (1887) p. 60.

Nachet's Dark-ground Illuminator.—This apparatus (fig. 103) consists of a truncated cone of glass, the base of which has the outer zone ground off to a spherical curve, leaving a central plane disc, which is blackened to exclude light. This cone is mounted in a cylindrical tube, with its base upwards, which is applied in the substage after the manner of the usual Continental cylindrical diaphragms, and racked up close to the transparent object. Parallel rays striking on the conical surface are refracted to the lenticular zone, and thence condensed on the object. M. A. Nachet, by whom the apparatus is constructed, states that "it should be used only with low powers having an angle of aperture less than that of the illuminator."

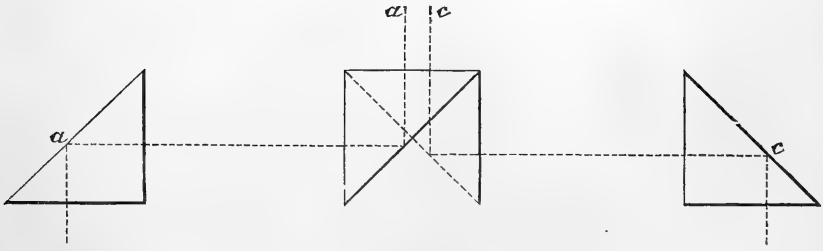
Fig. 103.



Quimby's Lamp-shade.*—Mr. B. F. Quimby's "illuminator" or lamp-shade is intended to be used with the Griffith Club Microscope. It consists of three pasteboard cylinders, accurately fitted one within the other—the external revolving on the middle, the inner being removable. All three cylinders are pierced anteriorly by a round aperture; the middle piece having also a slot. With the inner cylinder removed, the external piece may be twisted one way or the other, the pencil of light coming through the opening thus regulated; or, in the examination of diatoms, the slot may be used. The inner surface of the second cylinder is white, but for the convenience of those who prefer a black background, the inside of the third cylinder is of that colour, and this may be slipped into the illuminator whenever a dark surface is required. The middle cylinder is surrounded at its lower margin with a brass collar, to which a short tube is attached. Into this tube fits the lamp rod, while the illuminator rests on the rod controlling the light.

Van Heurck's Comparator.†—Dr. H. Van Heurck has derived the idea of his comparator from the instrument devised by M. Inostranzeff for comparing the colours of minerals.‡ The latter instrument, though

Fig. 104.

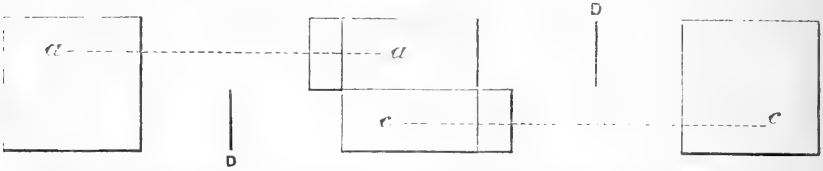


essentially practical, is insufficient for diatoms, as the field is partially intersected and a black band, where the prisms join, prevents perfect approximation. Moreover, it is preferable that the diatoms should be apposed not in their whole length but with half the length of the valve.

* The Microscope, vii. (1887) pp. 56–7.
† Bull. Soc. Belg. Micr., xiii. (1886) pp. 76–8 (2 figs.).
‡ See this Journal, 1886, p. 507.

The new apparatus works perfectly. Instead of two prisms, apposed by their edges, as in Inostranzeff's instrument, there are two prisms of large size, *a*, *c*, figs. 104 and 105, but of slight width and in apposi-

Fig. 105.

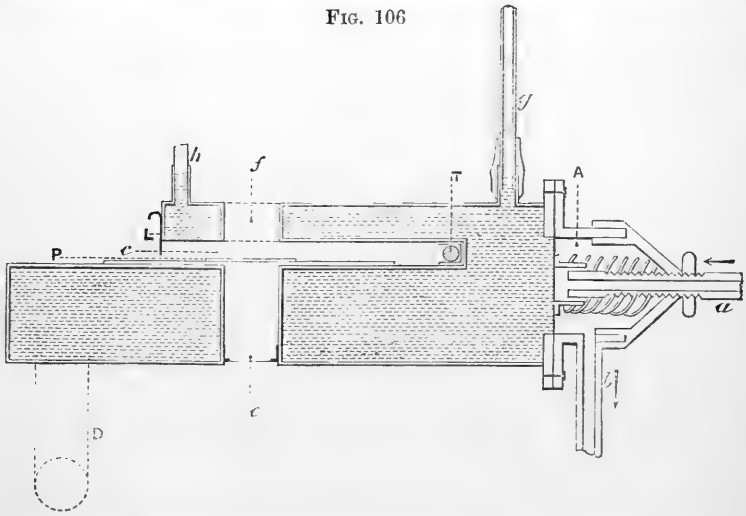


tion by one of their triangular faces. The two images are brought together in the direction of their length: the piece carrying the two prisms is movable, can turn on its axis, and be fixed in any position whatever. By slightly turning it, the line of separation of the two prisms altogether disappears, and so thoroughly, that a perfect valve can be made up of two halves of a valve, each belonging to one of the fields, and the photograph must be examined very attentively to find the place where the valves join.

Thus the comparisons are as complete as possible, and the images so clear that high powers may be used. In each part of the tube the diaphragms D cut off any interfering light coming from the opposite side.

Vignal's Hot Stage with Direct Regulator.*—M. W. Vignal's hot stage (fig. 106) consists of a rectangular brass box open on one side and con-

Fig. 106



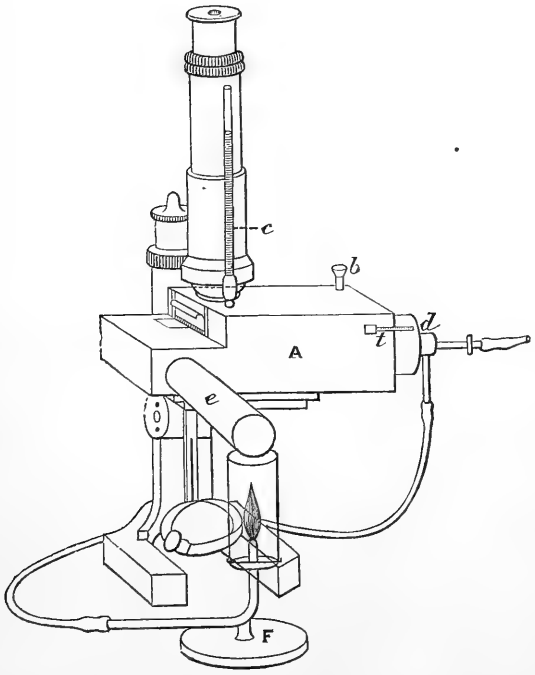
Longitudinal transverse median section of the hot stage. A, D'Arsonval's regulator; *a*, entrance tube for gas; *b*, exit tube for gas; *g*, glass tube fixed with caoutchouc band; *h*, tube for introduction of water; *c*, hot chamber proper, with slide P and thermometer T; L, door closing chamber; *f*, aperture for objective; *c*, glass disc in copper ring for closing the illuminating aperture; D, heating cylinder.

taining a second small rectangular box. These two boxes are perforated by an aperture which allows the light to be reflected upwards from the mirror.

* Arch. de Physiol., vi. (1885) pp. 1–10 (2 figs.).

The lower part of the aperture is closed by a small glass diaphragm, let into a copper ring. On the other side of the large box is fitted D'Arsonval's caoutchouc regulator; on the front side is a cylindrical diverticulum like that of a hot filter. On the upper surface are two brass tubes; to the front one is fixed, by means of a caoutchouc ring, a glass pipe into which the water rises in order to determine the pressure and consequently the regulation of the escape of gas; the other tube, closed by a caoutchouc plug, is that through which the box is filled with water and freed from gas or air. In front another tube passes through the chamber; in this is inserted a thermometer insulated by means of a piece of Bristol board. On the right side of the smaller box is a lateral opening for the insertion of the slide, and as the upper part of the larger box is wanting towards the right,

FIG. 107.



Showing the appearance of the hot stage arranged on the Microscope. A, hot chamber *b*, water tube; *c*, glass pressure tube; *d*, D'Arsonval's regulator; *e*, heating cylinder; F, burner with glass chimney; *t*, thermometer.

the defect serves for the easier manipulation of the slide. The hot stage proper is 5 mm. high, 75 mm. long, and 40 mm. broad, and in order not to lose heat a small door drops down just so far as not to interfere with the slide. The gas burner is inclosed in a glass chimney, in order to keep the flame quite steady.

The apparatus is put in working order as follows: The pressure tube having been arranged, the chamber is filled with boiling water, and is shaken from time to time in order to disengage any inclosed air. The apparatus is then placed on the stage, the gas lighted, and the regulator tap turned down until the flame begins to diminish. The tube is

then screwed up and the gas-jet placed at the end of the heating tube. As the water gets warm its excess escapes from the tube through which it was introduced. In about one hour to an hour and a half, when the thermometer marks 36° to 38° C., the tube is closed with the caoutchouc plug. As the water gets hotter it mounts in the glass tube and causes a pressure on the caoutchouc membrane of the regulator, and this lowers the flame by diminishing the current of gas supplied. If the temperature lowers the water descends and the gas is supplied more freely. Should the apparatus have been regulated for too high a temperature some water is introduced into the tube by means of a fine pipette, and *per contra* some is withdrawn by removing the caoutchouc plug if the temperature has been regulated too low. It is stated that the regularity of this hot stage is such that even under unfavourable conditions it does not vary more than a few tenths of a degree.

Julien's Immersion Heating Apparatus.*—Dr. A. A. Julien's "immersion apparatus" was devised for the special purpose of exactly determining the temperature of expansion of the liquid in the fluid cavities of minerals. He considers that most of the forms hitherto devised are "extremely inaccurate, often complex and untrustworthy, and it may be owing to this cause that Brewster obtained, for the critical temperature of the liquids in quartz, results of the very wide range between 20° and 51° C."

The author in a previous paper thus expressed himself on the subject. "The objection to all these forms of apparatus lies in their irregular application of heat, and its irregular and indefinite loss from currents in the surrounding atmosphere, and from the refrigerating effect of the mass of metal in the stage, and also in the objective, in an amount proportionate to its close approximation, i. e. to its focal distance or high power. Even in the most pretentious apparatus, that of Vogelsang, its inventor admits a variation or error of 10° C., according to the objective employed; from a No. 4 Hartnack of 3 mm. focal distance to a No. 9 of 0·1 mm. Vogelsang suggested the reduction of observations made by means of high-power objectives to the standard of the No. 4, and was even forced to make a plus correction of 1° C. for observations in which the temperature of the air of the room and of the Microscope fell below his normal (20° C.) as far as 12° to 15°. Practically, in use these observations are consequently made almost altogether on large cavities and under low-power objectives, and an accuracy to 1° C. has been accepted as satisfactory. Although wide discrepancies have constantly occurred, even in determinations on the fluid cavities in the same slice of mineral by means of these devices, on the other hand some of the most delicate and important investigations, such as those of Sorby and King on the indication of the degrees of pressure to which certain granites have been subjected during folding and metamorphism, have rested largely upon the accuracy of determinations of this very kind." †

Brewster, Sorby, and Hartley have used the same principle as the author, Hartley adopting the plan of immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the stage, and instantly examining it ‡ Far more accurate results with greater convenience can, however, be obtained by means of an apparatus permitting the slide to remain under observation, immersed in a layer of water on the stage, and continuously warmed by a current of air from the breath of the observer, or, if necessary, by the conduction of heat to the bottom of the

* Journ. N. York Micr. Soc., i. (1885) pp. 137-9. See also this Journal, 1882, p. 266.
† Amer. Mon. Micr. Journ. v. (1884) pp. 189-90.
‡ Journ. Chem. Soc. London, 1876, p. 139.

vessel from a small flame at the side of the stage. By this means an accurate determination of the actual temperature at which a fluid inclusion expands into a gaseous state may be obtained in a few minutes to 0·05 C°.

The simplest form of the apparatus consists of three parts, as follows:—

1. A shallow glass tank, such as may be cut off the bottom of a chemical beaker, of sufficient diameter for the slide to lie within it, just immersed in a thin layer of water, but separated from the bottom by two little blocks of rubber or glass. This tank is placed upon the stage.

2. A chemical thermometer of sufficient delicacy, with a short bulb, or with a long bulb bent at a right angle. This is inserted in the tank, as nearly upright as possible, and the depth of the water is made just enough to cover the bulb. The length of the scale should be such as to bring the degrees between 27° and 32° near the level of the observer's eye when it is at the eye-piece, to facilitate immediate observation without the delay caused by moving the head.

3. A piece of small rubber tubing tied to the body of the stand, with the upper end inserted in the observer's mouth, and with the lower end, which terminates in a short piece of glass tubing drawn to a fine aperture, lying in the water on the bottom of the tank.

An immersion objective may be employed or, if the cavity be large, any objective of lower power may be used, with its front immersed in the water. After the cavity has been brought into sharp focus, a steady but gentle stream of air is blown through the tube, the immersion of the objective preventing interference from the waves on the surface of the agitated water. The cavity is continuously observed, as the bath and the immersed thin section are gradually warmed by the current of the observer's breath, and when the critical point is reached and the liquid contents of the cavity suddenly disappear, a quick observation of the thermometer is made.

Again, as the bath cools—which process may in hot weather be hastened by adding carefully a few drops of cool water, with continual agitation by the air current—the original bubble may be observed to leap back into view, and a second observation of the thermometer is taken as a check to the first.

If a higher temperature be required for other uses of this apparatus, oil or other liquid may be substituted for the water in the bath, and it may be heated by conduction from a taper or lamp burning by the side of the stage, through a stiff slip of copper introduced beneath the glass tank. A small hole, for observation, through this copper slip should be placed immediately over the centre of the aperture of the stage. The apparatus may be further protected from radiation of heat, and more uniform results ensured, by inclosing the tank in a ring of pasteboard or sheet cork, and by inserting plates of cork between the copper plate and the stage.

Unequal Heating of Crystal Sections.*—Dr. W. Klein, for studying the alterations of optical characters in crystals, produced by unequal heating, suggests the use of a plate of copper, resting upon one side of the crystal, the other end of the plate being heated in a spirit-lamp. To accelerate the process, and to obtain the means of rotating the section during heating, it is better to use a pair of copper forceps attached to a wooden ring, so that the points of the forceps in which the section is held come exactly into the centre of the ring; between the ring and the forceps is a layer of asbestos. The whole is laid upon the stage, and the projecting end of the forceps heated by a spirit-lamp. By this method the crystal is heated on one side on both the upper and lower surfaces.

* Zeitschr. f. Krystallogr. u. Mineral., ix. (1884) pp. 38–72.

Culture Glass for examining Micro-organisms.*—The glass invented by Dr. F. Lipež consists of a flat and a round part. The former is for the reception of the nutrient medium; the latter for the cotton-wool plug.

Fig. 108.

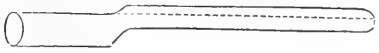


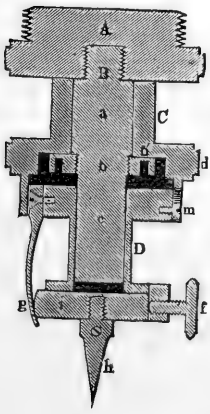
Fig. 109.

Fig. 108 shows the instrument in section; fig. 109 from the surface. One-third the natural size.

The nutrient medium is only spread in a thin layer on the lower surface of the glass. The advantages claimed for this glass over the ordinary plate method are: (1) The simplicity of its application, for it is a storehouse as well as a laboratory; (2) its certainty of preventing ingress of extraneous organisms, &c; (3) it allows the colonies to be examined with low powers, and to be extracted for examination if need be; (4) it allows the action of certain gases in the organisms to be observed with facility—e.g. CO^2 can be poured in and H gas poured up, according to the position of the aperture.

Schiefferdecker's Apparatus for Marking Microscopical Objects.†—Dr. P. Schiefferdecker's apparatus (fig. 110) is essentially a diamond point for scratching circles on the cover-glass, so that any particular spot can be easily found.

Fig. 110.



It consists of the screw-head A, to which is united the piece B, of unequal length and diameter at *a* and *c*. At *b* are a few threads for working in the female screw *b'*, which supports the revolving cylinder C, but without interfering with its movements. C is united to a second revolving cylinder D by means of the screw *m*. A linear aperture at *m* allows free up and down movement of the parts from D to *h*. The horizontal slide *i* is moved by the screw *f* and the spring *g*. At the end of *h* is a diamond point. The apparatus is screwed to the body-tube in place of the objective, and *h* is moved out excentrically to the desired extent, and a circle is scratched on the cover-glass by turning the raised rim *d* round through 360°. By this means circles of 0·25 to 0·20 mm. diameter can be described. Of course it is necessary that the cover-glass should be firmly fixed.

Microscopic Measurement of Indices of Refraction and Axial Angle of Minerals.—M. E. Bertrand ‡ is able to observe the optic axes in a mineral of which the true axial angle is 145°, by increasing the aperture of the condenser and objective, and using a strongly refracting immersion liquid. For this purpose, the condenser consists of three lenses, which are respectively hemispherical of 5 mm. radius, 5 mm. thick with 12 mm. radius, and 19 mm. diameter with 60 mm. focal length; the objective consists of 3 lenses which are respectively hemispherical of $1\frac{1}{2}$ mm. radius,

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 401–2 (2 figs.).
† Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 461–4 (1 fig.).
‡ Bull. Soc. Min. de France, viii. (1885) pp. 29–31, 377–83.

3 mm. thick with 5 mm. radius, 2 mm. thick with 12 mm. radius. The polarizer need not have a field of more than 20°. For sections of from 0·1–0·01 mm. thickness a fourth lens of 13 mm. diameter and 4·5 mm. focal length is added to the objective, and to obviate the difficulty of mounting very small fragments of crystals for the measurement of the axial angle, this fourth lens, together with the eye-piece and analyser, is made to turn about an axis perpendicular to the axis of the Microscope, and passing through the section, the angle of rotation being measurable.

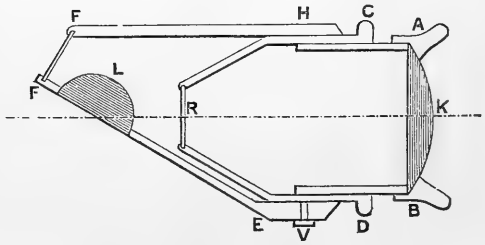
In making the measurement the whole body-tube is depressed until the objective is in contact with the section in the immersion liquid; adjustment to a satisfactory part of the section is then made by the eye-piece tube, and the upper part of the tube is raised until the interference curves are seen; the angle is then measured by rotation about the axis mentioned above. Since a certain rotation of the upper part of the tube corresponds to the angle of total reflection, this disposition of the instrument renders it possible to measure the index of refraction at the same time.

On the same principle M. Bertrand has constructed a new refractometer for rock sections.* The rotation of the upper part of the tube is here replaced by a rotation of the hemispherical lens, which is now fixed to the axis of a small goniometer, carried by a separate pillar mounted on the Microscope-stand. The objective of the Microscope consists of an achromatic lens of 30 mm. focal length, and above it is a diaphragm with a slit 1/4–1/2 mm. in breadth, and 3 mm. in length, parallel to the axis of the goniometer.

The section together with the polarizer is kept in contact with the hemispherical lens by a spring. When the limit of total reflection is reached by a rotation of the goniometer axis, the upper part of the section is bright and the lower part dark, so that the boundary line may be adjusted to the cross wire. The section is illuminated from above by means of a hole in a screen which allows the light to fall only upon the mineral under examination. When the instrument is carefully adjusted, this method will give the refractive index correct to 2 or 3 units in the third decimal place.

Bertrand's Refractometer.†—This instrument, designed by M. E. Bertrand, may be used for solids or liquids, and gives the index correct to two places of decimals by a single reading.

FIG. 111.



A B, fig. 111, is the eye-piece carrying a lens of crown glass of 4 cm. focus; it slides in the tube C D which is conical at the further end, and is provided with a reticule R consisting of a glass disc 8 mm. in diameter engraved with 80 divisions, 1/10 mm. apart and numbered by tens. C D slides in the tube E F F H, the lower face of which is an elliptical section, making an angle of 30° with the axis, and carrying the hemispherical flint-glass lens L of 5 mm. radius fixed in a copper disc. The plane surface of this lens faces outwards, and its centre is in the axis

* Bull. Soc. Min. de France, viii. (1885) pp. 426–8, and ix. (1886) pp. 15–21.

† Op. cit., viii. (1885) pp. 375–7. Cf. Le Génie Civil, and Eng. Mech., xliii. (1886) p. 453 (1 fig.).

of the instrument. F F is a small aperture filled with ground glass which admits light, and V is a screw to fix the tube C D when it is so adjusted that R is at the focus of the lens.

To find the index of a liquid, a drop is placed upon the plane surface of L; of the rays refracted through L, those which have an angle of incidence greater than the critical angle are totally reflected at the surface of the liquid, and illuminate the lower portion of the reticule; the upper part remains dark, and the position of the boundary line depends upon the critical angle, and, therefore, upon the index; if then the value of the graduations is known, the index is read directly from the position of this line upon the scale.

For solids, a polished plane surface is placed against the lens, a liquid of higher index having been interposed between them, two boundary lines are then seen, one of which belongs to the liquid, and the other to the solid; the latter gives the required index directly.

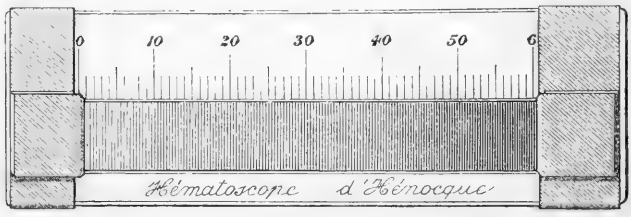
M. Bertrand uses as an immersion liquid, with substances of high refractive index, dibromated naphthyl-phenylacetone, to which a few drops of bromated naphthalene have been added.

The instrument is graduated by determining the position of the boundary line for different solids and liquids of known refractive index.

Hæmatoscopy.* — M. Hénocque under this name indicates a new spectroscopic method of analysing the blood. This method comprises two modes of observation: 1st, the determination of the quantity of oxyhæmoglobin by instruments called *hæmatoscopes* and *hæmatospectroscopes;* 2nd, an estimation of the time of reduction of the oxyhæmoglobin by spectroscopic examination through the thumb-nail. The ratio of these serves to measure the activity of the reduction.

In the estimation of the quantity of active colouring matter by the hæmatoscope an apparatus is used (fig. 112) which consists of two super-

Fig. 112.



posed plates of glass which are in contact at one end and are separated by an interval of 0·03 mm. at the other; a few drops of undiluted blood inserted between the plates form a layer of gradually increasing thickness and intensity of colour, and the thickness is measured by a millimetric scale engraved on the glass. The amount of colouring matter is estimated by observing the point of the scale at which the two characteristic bands of oxyhæmoglobin appear equally dark in a direct vision spectroscope. For example, blood containing 14 per cent. of oxyhæmoglobin examined by daylight will give two bands of equal darkness with a thickness of 0·07 mm., the bands are also of equal breadth and occupy the spaces 530 to 550 and 570 to 590 in the spectrum measured in wave-lengths; the percentages of oxyhæmoglobin corresponding to different points of the scale are given by a comparative table.

* Comptes Rendus, ciii. (1886) pp. 817–20 (3 figs.).

On looking through the thumb-nail with a direct-vision spectroscope the first characteristic band is seen, sometimes accompanied by the second. When a ligature is made round the joint the bands disappear, the yellow at the border of the ray D then slowly reappears, and finally the bands disappear entirely; the time occupied is the *time of reduction*, and varies between 25 and 90 seconds, the normal time being about 60 seconds in health and in a state of rest; it is connected with the quantity of oxyhæmoglobin and the rapidity of exchange between the blood and the tissues.

Fig. 113 represents a hæmatospectroscope with the lateral movements which are required to study the phenomenon of the two bands; it is provided with a micrometric scale divided in wave-lengths. Fig. 114 is a

Fig. 113.

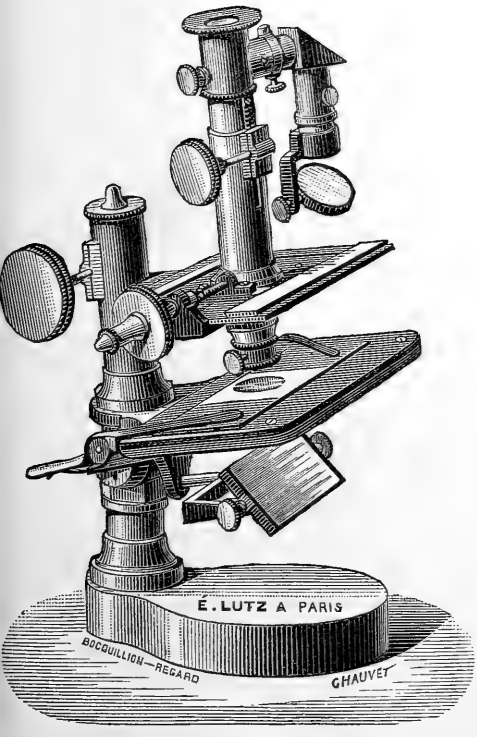
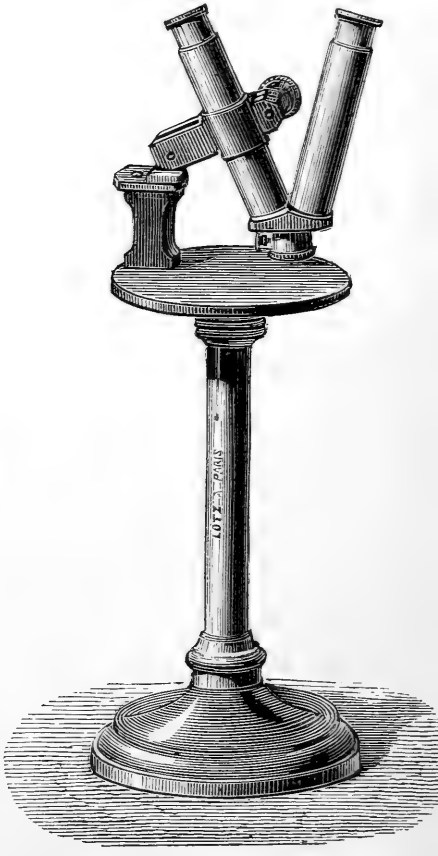


Fig. 114.

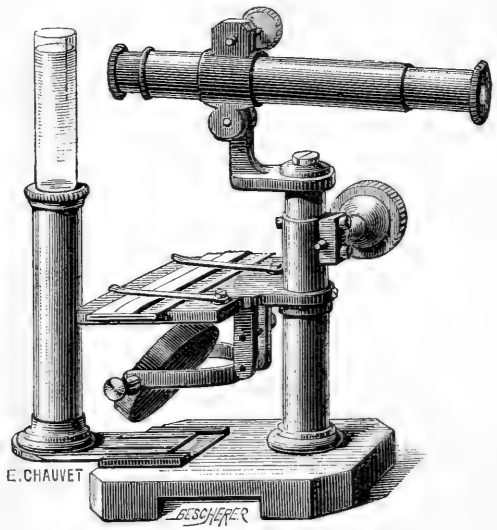


double hæmatospectroscope with a single slit by which two persons can observe the same phenomena simultaneously. The form shown in fig. 115 allows the spectroscope to be placed horizontally.

Experiment having shown that in the normal condition when the blood contains 14 per cent. of oxyhæmoglobin the mean time of reduction is

66 seconds, it may be assumed that the quantity reduced in one second is 0·20 per cent. If this quantity be taken as the unit of activity of reduc-

Fig. 115.



tion, then the following formula gives the activity corresponding to any values of the time of reduction and quantity of oxyhæmoglobin determined by the above methods.

$$\text{Activity of reduction } \epsilon = \frac{\text{quantity of oxyhæmoglobin}}{\text{time of reduction}} \times 5.$$

Hayem's Chromometer.—Prof. G. Hayem's apparatus for measuring the quantity of hæmoglobin in the blood consists of two cells arranged on

Fig. 116.

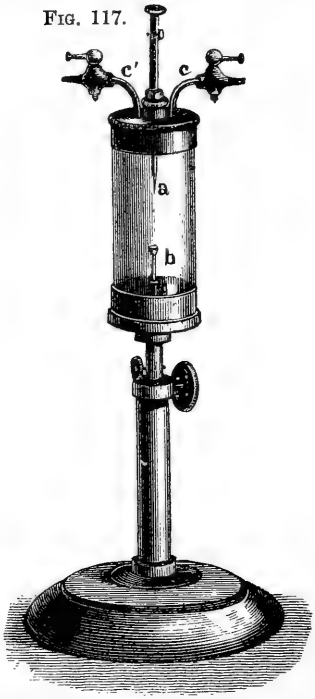
a slide as in fig. 116, one of which is filled with dilute blood and the other with pure water, the slide being placed on a standard colour for comparison.

Spectrum Analysis in Micro-Mineralogy.*—Dr. K. de Kroustchoff believes that he has found a method which, by the aid of spectrum analysis, will allow quantities that are unrecognizable by ordinary means to be easily identified. For this purpose he uses an apparatus which consists of a glass cylinder closed at both ends by a brass cap. In the upper cap is a stuffing-box, through which a brass rod, with a platinum point for an electrode *a*, plays up and down. Through the upper cap also pass two brass tubes,

* Bull. Soc. Mineral. France, vii. (1884) pp. 243–9 (1 pl.).

fitted with taps *c* and *c'*. The lower cap is also provided with a brass rod, upon which, by means of a screw, can be fastened bits of metal or carbon, *b*. This is the second electrode. The small cones of birch-wood charcoal are freed as far as possible from foreign bodies by prolonged treatment with acids and alkalis, followed by prolonged boiling. The carbons can now be used in various ways. If liquid, the carbons are soaked therein. Other matter is first heated in a platinum vessel with dry chlorine gas. The gas with chlorides is then passed through a tube containing some carbons, which become impregnated by the substances. Combinations other than chlorides are deposited on the walls of the tube; these are placed in a hole in the carbon, or in small platinum or aluminium cups soldered to *b*.

FIG. 117.



When the substance to be examined is arranged in the apparatus, the latter is filled with dry hydrogen, and the electrodes united with the poles of a battery. When the current is closed the spectrum is observed.

By this method a thin microlith, 0·02 mm. by 0·001 mm., observed in a piece of Podolsk quartz, was found to consist of aluminium, beryl, and silicon; consequently the microlith was beryl.

COPPER.—**Achromatic Condensers.** *Engl. Mech.*, XLV. (1887) p. 300.

GILL, R.—**Camera Lucida.**
[Describes one made of a cover-glass, and costing the fraction of a penny.]
Sci.-Gossip, 1887, p. 116.

LEACH, W.—**The Lantern Microscope.**
[Describes his arrangements for illumination.]
Engl. Mech., XLV. (1887) pp. 50–1.

TERRY, W. A.—**Notes on Diatom Study.**
[Varnish cell 1/100 in. thick for studying motions of diatoms.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 44–6.

TRŒSTER, C.—**Hilfsvorrichtung für das Mikroskopiren bei Lampenlicht.** (Contrivance for use with the Microscope by lamplight.)
[Plate of blue-tinted glass, one side of which is dull, placed in the aperture of the stage so that the mirror and condenser form an image of the lamp-flame upon the dull surface. This will be found to obviate the two chief objections to the use of lamplight, namely, the colour, and the parallelism of the rays which gives rise to interference phenomena.]
Zeitschr. f. Instrumentenk., VII. (1887) p. 65.

(4) Photomicrography.

Photographic Apparatus for the Microscope.—The introduction of dry plates has given such an impetus to photomicrography, that in the course of last year we commenced to collect the illustrations for an extended notice of the various forms of photomicrographic apparatus. On reviewing them, however, we fear that many have now scarcely more than an historical

interest, and we have therefore made a limited selection (hardly more than a quarter!) which may serve to give a few hints to any who desire to contrive any variations on the forms hitherto in use.

I. Of those which have now a purely historical interest only, are Prof. *J. Gerlach's* * (fig. 118) and *Möller and Emmerich's* † (fig. 119). These require no description.

Fig. 118.

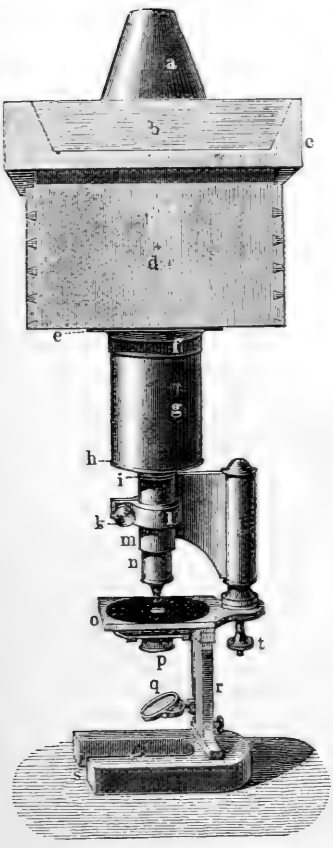


Fig. 119.

Nearly the same remarks apply to the complicated arrangements of *Dr. B. Benecke* ‡ (figs. 120 and 121) intended for use with the highest powers.

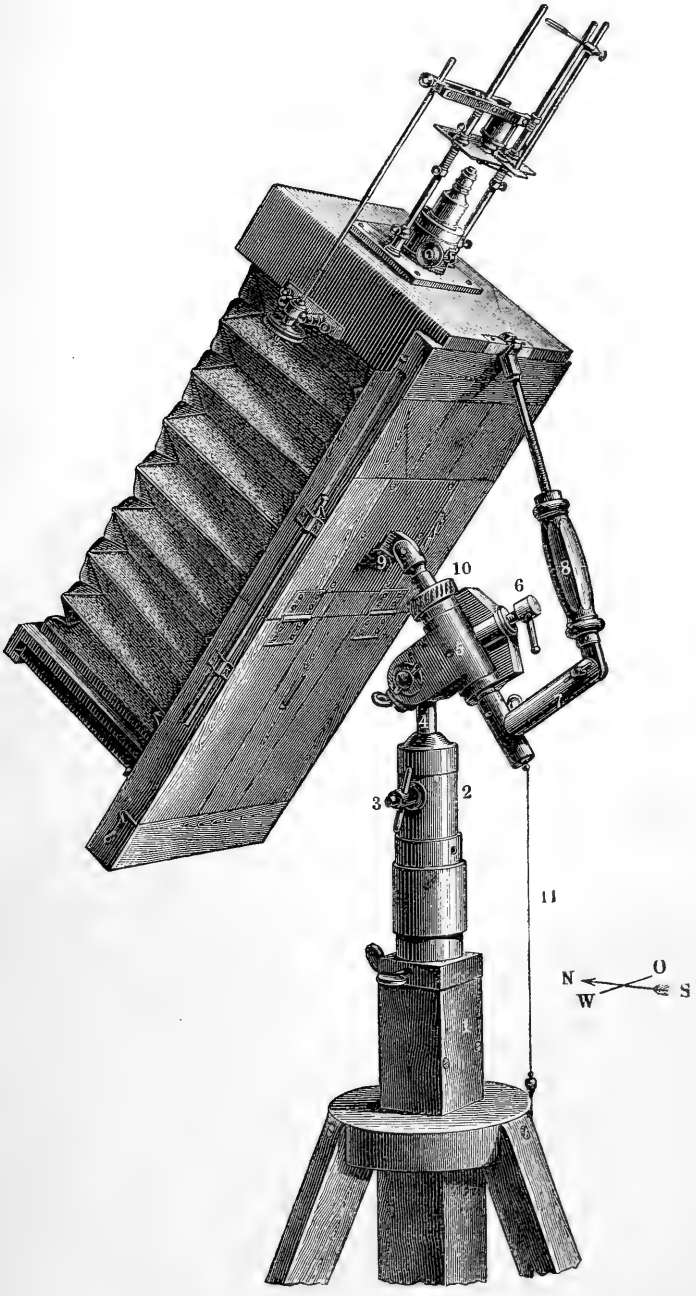
Fig. 120 shows the camera as mounted on a stand for use with direct sunlight and without any mirror. The stand is so contrived that when once

* 'Die Photographie als Hülfsmittel mikroskopischer Forschung,' 1863, viii. and 86 pp., 9 figs. and 4 pls. of photomicrographs.

† Cf. Dippel's 'Das Mikroskop,' 1867, p. 211–3 (2 figs.).

‡ 'Die Photographie als Hilfsmittel mikroskopischer Forschung (nach dem Französisch von Dr. A. Moitessier).' 1868, xiv. and 265 pp., 88 figs. and 2 pls. of photomicrographs.

FIG. 120.



then screwed up and the gas-jet placed at the end of the heating tube. As the water gets warm its excess escapes from the tube through which it was introduced. In about one hour to an hour and a half, when the thermometer marks 36° to 38° C., the tube is closed with the caoutchouc plug. As the water gets hotter it mounts in the glass tube and causes a pressure on the caoutchouc membrane of the regulator, and this lowers the flame by diminishing the current of gas supplied. If the temperature lowers the water descends and the gas is supplied more freely. Should the apparatus have been regulated for too high a temperature some water is introduced into the tube by means of a fine pipette, and *per contra* some is withdrawn by removing the caoutchouc plug if the temperature has been regulated too low. It is stated that the regularity of this hot stage is such that even under unfavourable conditions it does not vary more than a few tenths of a degree.

Julien's Immersion Heating Apparatus.*—Dr. A. A. Julien's "immersion apparatus" was devised for the special purpose of exactly determining the temperature of expansion of the liquid in the fluid cavities of minerals. He considers that most of the forms hitherto devised are "extremely inaccurate, often complex and untrustworthy, and it may be owing to this cause that Brewster obtained, for the critical temperature of the liquids in quartz, results of the very wide range between 20° and 51° C."

The author in a previous paper thus expressed himself on the subject. "The objection to all these forms of apparatus lies in their irregular application of heat, and its irregular and indefinite loss from currents in the surrounding atmosphere, and from the refrigerating effect of the mass of metal in the stage, and also in the objective, in an amount proportionate to its close approximation, i. e. to its focal distance or high power. Even in the most pretentious apparatus, that of Vogelsang, its inventor admits a variation or error of 10° C., according to the objective employed; from a No. 4 Hartnack of 3 mm. focal distance to a No. 9 of 0·1 mm. Vogelsang suggested the reduction of observations made by means of high-power objectives to the standard of the No. 4, and was even forced to make a plus correction of 1° C. for observations in which the temperature of the air of the room and of the Microscope fell below his normal (20° C.) as far as 12° to 15°. Practically, in use these observations are consequently made almost altogether on large cavities and under low-power objectives, and an accuracy to 1° C. has been accepted as satisfactory. Although wide discrepancies have constantly occurred, even in determinations on the fluid cavities in the same slice of mineral by means of these devices, on the other hand some of the most delicate and important investigations, such as those of Sorby and King on the indication of the degrees of pressure to which certain granites have been subjected during folding and metamorphism, have rested largely upon the accuracy of determinations of this very kind." †

Brewster, Sorby, and Hartley have used the same principle as the author, Hartley adopting the plan of immersing the slide in water of known temperature, removing, wiping it hastily, placing it on the stage, and instantly examining it ‡ Far more accurate results with greater convenience can, however, be obtained by means of an apparatus permitting the slide to remain under observation, immersed in a layer of water on the stage, and continuously warmed by a current of air from the breath of the observer, or, if necessary, by the conduction of heat to the bottom of the

* Journ. N. York Micr. Soc., i. (1885) pp. 137-9. See also this Journal, 1882, p. 266.
† Amer. Mon. Micr. Journ. v. (1884) pp. 189-90.
‡ Journ. Chem. Soc. London, 1876, p. 139.

vessel from a small flame at the side of the stage. By this means an accurate determination of the actual temperature at which a fluid inclusion expands into a gaseous state may be obtained in a few minutes to 0·05 C°.

The simplest form of the apparatus consists of three parts, as follows:—

1. A shallow glass tank, such as may be cut off the bottom of a chemical beaker, of sufficient diameter for the slide to lie within it, just immersed in a thin layer of water, but separated from the bottom by two little blocks of rubber or glass. This tank is placed upon the stage.

2. A chemical thermometer of sufficient delicacy, with a short bulb, or with a long bulb bent at a right angle. This is inserted in the tank, as nearly upright as possible, and the depth of the water is made just enough to cover the bulb. The length of the scale should be such as to bring the degrees between 27° and 32° near the level of the observer's eye when it is at the eye-piece, to facilitate immediate observation without the delay caused by moving the head.

3. A piece of small rubber tubing tied to the body of the stand, with the upper end inserted in the observer's mouth, and with the lower end, which terminates in a short piece of glass tubing drawn to a fine aperture, lying in the water on the bottom of the tank.

An immersion objective may be employed or, if the cavity be large, any objective of lower power may be used, with its front immersed in the water. After the cavity has been brought into sharp focus, a steady but gentle stream of air is blown through the tube, the immersion of the objective preventing interference from the waves on the surface of the agitated water. The cavity is continuously observed, as the bath and the immersed thin section are gradually warmed by the current of the observer's breath, and when the critical point is reached and the liquid contents of the cavity suddenly disappear, a quick observation of the thermometer is made.

Again, as the bath cools—which process may in hot weather be hastened by adding carefully a few drops of cool water, with continual agitation by the air current—the original bubble may be observed to leap back into view, and a second observation of the thermometer is taken as a check to the first.

If a higher temperature be required for other uses of this apparatus, oil or other liquid may be substituted for the water in the bath, and it may be heated by conduction from a taper or lamp burning by the side of the stage, through a stiff slip of copper introduced beneath the glass tank. A small hole, for observation, through this copper slip should be placed immediately over the centre of the aperture of the stage. The apparatus may be further protected from radiation of heat, and more uniform results ensured, by inclosing the tank in a ring of pasteboard or sheet cork, and by inserting plates of cork between the copper plate and the stage.

Unequal Heating of Crystal Sections.*—Dr. W. Klein, for studying the alterations of optical characters in crystals, produced by unequal heating, suggests the use of a plate of copper, resting upon one side of the crystal, the other end of the plate being heated in a spirit-lamp. To accelerate the process, and to obtain the means of rotating the section during heating, it is better to use a pair of copper forceps attached to a wooden ring, so that the points of the forceps in which the section is held come exactly into the centre of the ring; between the ring and the forceps is a layer of asbestos. The whole is laid upon the stage, and the projecting end of the forceps heated by a spirit-lamp. By this method the crystal is heated on one side on both the upper and lower surfaces.

* Zeitschr. f. Krystallogr. u. Mineral., ix. (1884) pp. 38–72.

FIG. 126.

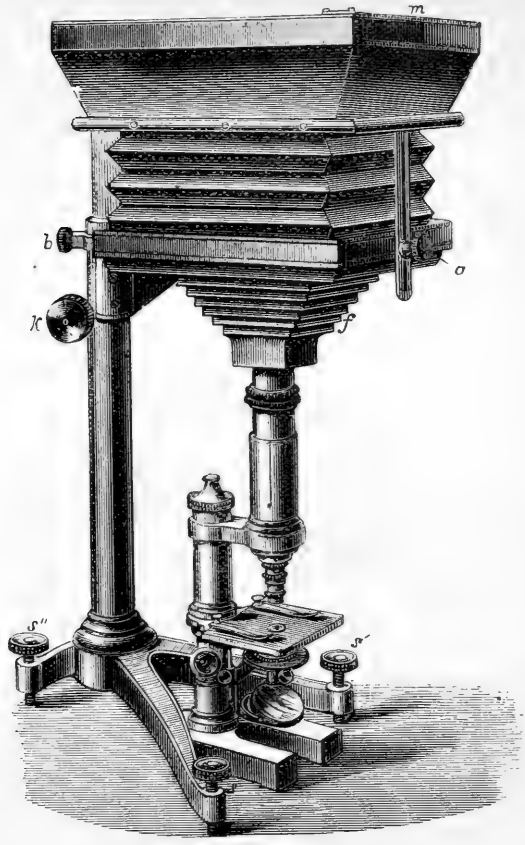
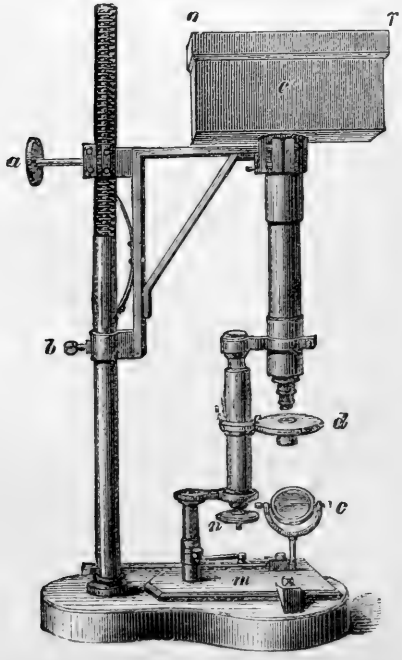


FIG. 127.



Prof. A. Girard's Photomicrographic Camera as made by M. Nachet (fig. 128) allows of the observer remaining seated and conducting all the

FIG. 128.

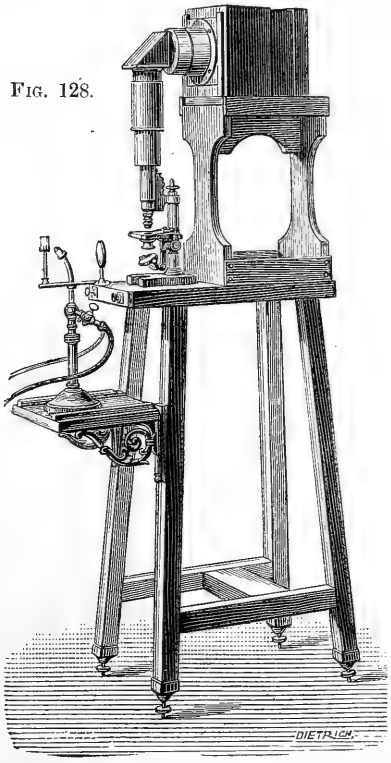
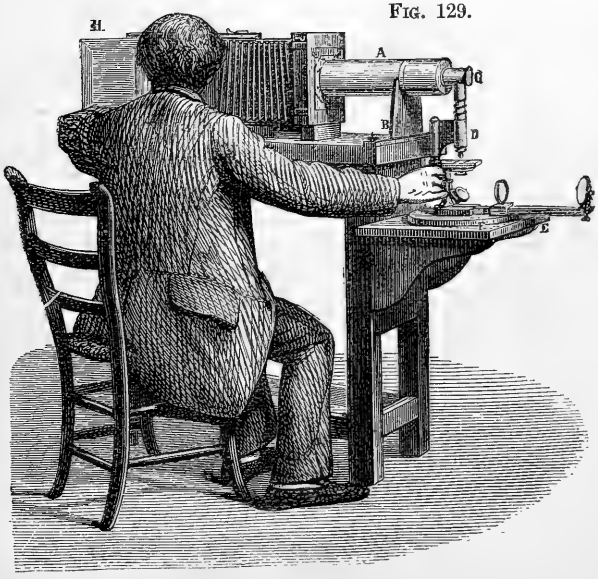


FIG. 129.



necessary manipulations at the length of the arm, and with a vertical Microscope. Focusing, adjustment of illumination, &c., can be done with the hand without moving from the seat, and without having to leave the image. This is accomplished by placing at the end of the tube of the camera a plane silvered mirror at an angle of 45°, which receives the rays from the Microscope and deflects them into the camera. Any Microscope can be used. The stand has a bracket for an oxyhydrogen or electric lamp.

Dr. A. Moitessier earlier described * a somewhat similar arrangement which took the form shown in fig. 129. It has the side door for focusing described in this Journal, 1886, p. 841.

Fig. 130.

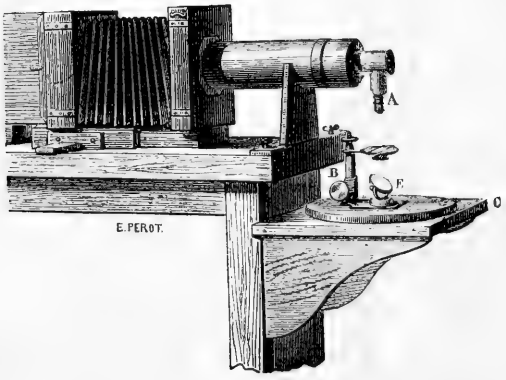
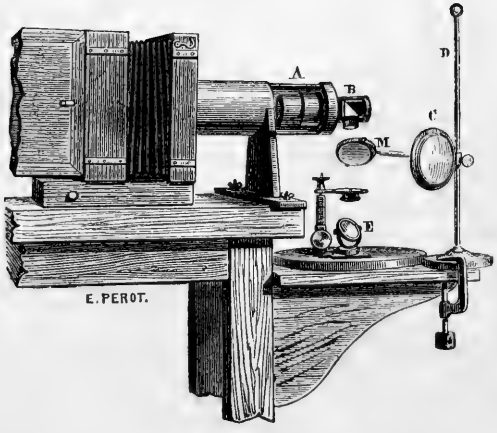


Fig. 131.



The latter form is also readily adapted for cases where small (fig. 130), or very small (fig. 131), enlargements (3–5) are required.† In the latter

* Op. cit., p. 131.

† Ibid., pp. 136 and 138.

case a photographic objective is placed behind the prisms. The adjustment for focus is made by moving the stage. These forms are specially suitable for opaque objects.

In *Nachet's* photomicrographic camera (figs. 132 and 133), M. A. Nachet has provided for its use either in a vertical, inclined, or horizontal position. This is accomplished by attaching it to two upright supports which can be

FIG. 132.

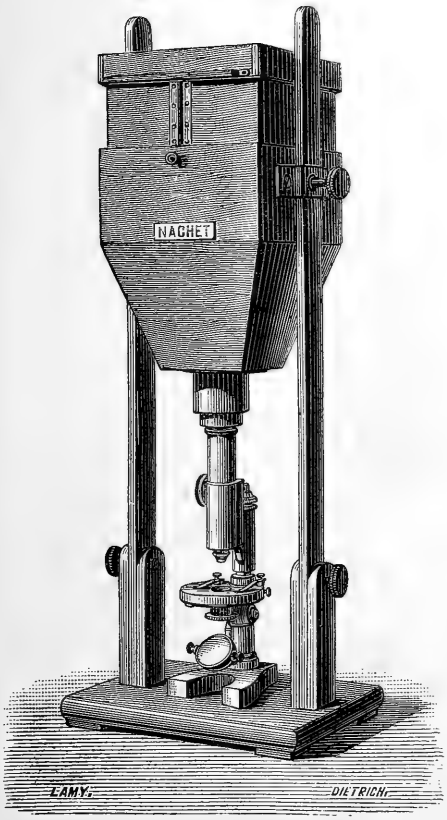
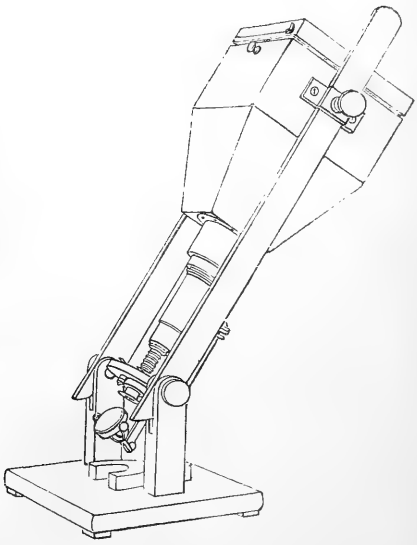


FIG. 133.



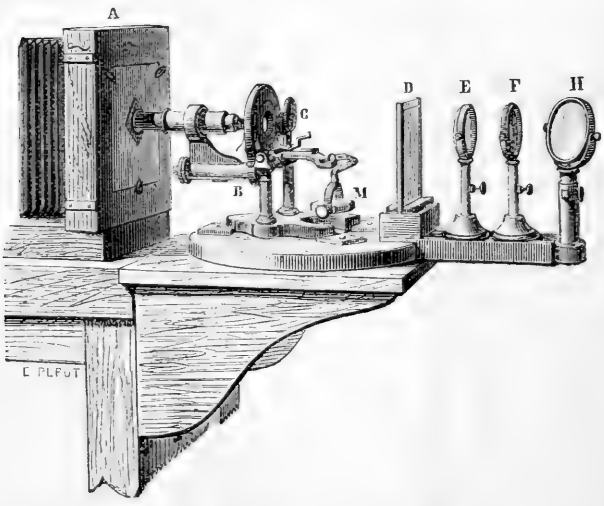
inclined on two short pillars fixed to the wooden base on which the Microscope is placed. The camera is also arranged to slide on the supports so that it can be raised or lowered, and set at different heights. Adapter-tubes of special construction are applied to the body-tube to connect it with the camera, which are so arranged that the focal adjustments of the Microscope are made independent of the adjustment of the camera, and at the same time no extraneous light is allowed to enter at the connection.

III. *Cameras for Horizontal Microscopes.*—Of these there are an endless number :—*Moitessier's* * (fig. 134) makes use of an ordinary Microscope.

* Op. cit., p. 134.

In *Reichert's* apparatus (fig. 135) the camera C slides on a base-board between guides *a* and *b*, a graduated scale and index *z* recording the position. It can be levelled by screws *s* at one end. The lengthening-piece Z is removable when the camera is required to be brought nearer to the Micro-

Fig. 134.



scope. The ground glass is moved by rack and pinion T, or for fine-adjustment by *m*.

The Microscope D is connected with the camera by a light-proof connection at K, and is fastened to the base by a screw at F. The fine-adjustment screw head E is toothed, and is turned by a larger toothed wheel *u* which is actuated by the prism *g* at the end of the rod *Sp*. The other end of the rod reaches to *k* where it is turned by the milled head *h*.

For illumination by transmitted light a mirror P and condensing lens L slide in the groove *l*. There is also a holder B for holding fluids, either for controlling the illumination or for stopping the heat rays. For opaque objects there is a second mirror H on a support *r*.

Seibert's (fig. 136) and *Vérick's* (fig. 137) have each special arrangements for focusing. In the original form of the former the screw head had teeth cut in it in which a toothed wheel worked, the wheel being actuated by a double-jointed rod. This is now modified, as shown in the fig., a system of pulleys and cords being used. In the latter there is a rod and one pulley, the head of the fine-adjustment screw being also grooved to receive the cord.

For photomicrography *Dr. Zeiss* modifies his No. 1 stand as shown in fig. 138. The chief differences are that the body is shorter and of greater diameter, so as to interfere as little as possible with the cone of rays transmitted by the objective, and that there is an extra large (140 × 120 mm.) mechanical stage with circular and rectangular motions. The draw-tube is also tapped at its lower end with the ordinary objective thread, to receive when required a photographic correcting lens, to correct the objective for a picture 1 to 1½ metres distant. The stage and body-tube are fixed and do not revolve round the optic axis.

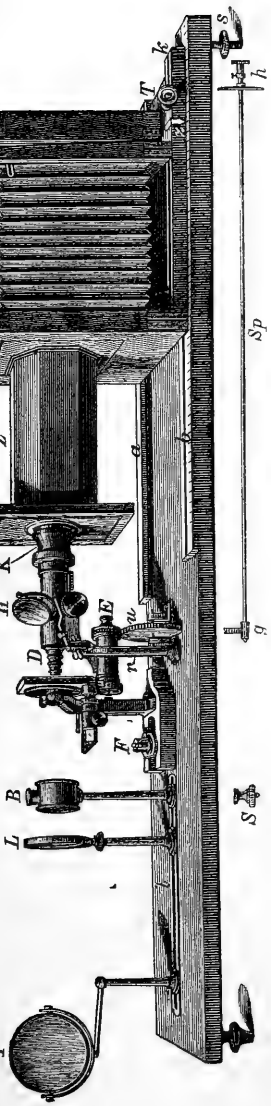


FIG. 135.

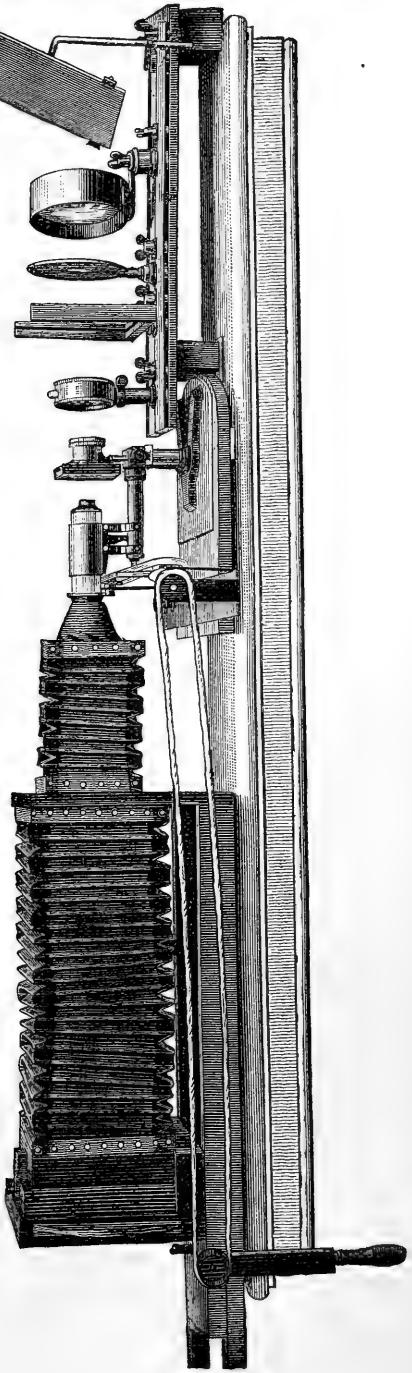


FIG. 136.

The larger form of camera is shown in fig. 138. It consists of an ordinary mahogany photographic camera of medium size, with extending arrangement, lengthening to about one metre, the amount of extension being registered on a scale on the lower part of the camera. There are two

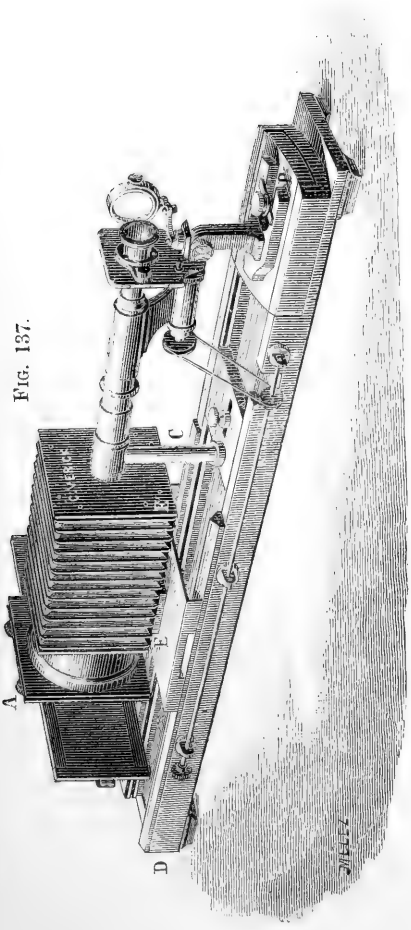


Fig. 137.

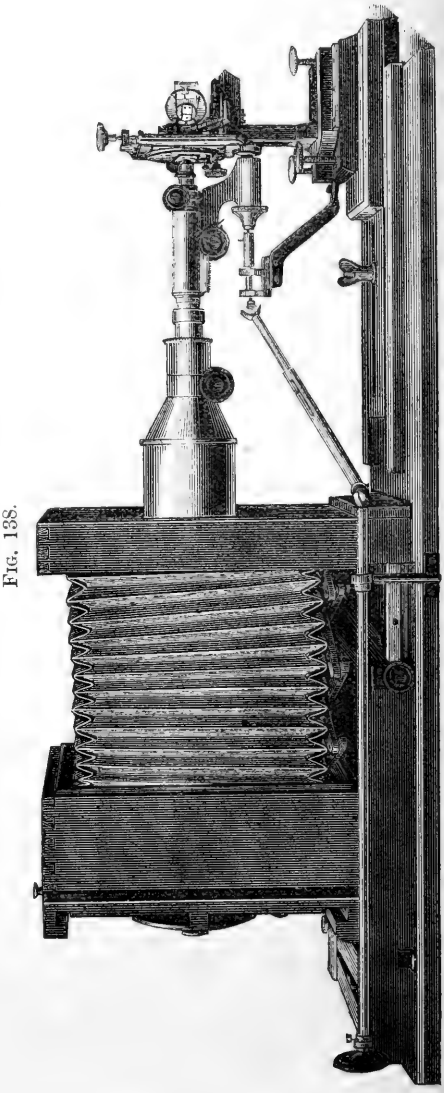


Fig. 138.

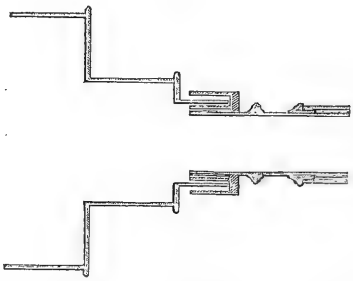
slides for plates, 23 cm. square, with wooden frames for plates of smaller dimensions.

The camera is fastened to a strong wooden base which also carries the Microscope, the fine-adjustment being worked by a long Hooke's joint. The Microscope does not stand directly on the wooden base, but on a heavy

metal plate on a wooden support. The former allows the axis of the Microscope to be brought into line with that of the camera by moving it laterally by hand; it is also adjustable by three screws. The wooden support can be freely moved to and from the camera, between guides on the base.

The end of the camera which is turned to the Microscope has a long brass nozzle, blackened inside, which carries a brass jacket moved by rack and pinion. This jacket is inserted into a double cap fitting on the end of the body-tube as shown in fig. 139. A connection between the camera and the Microscope is thus made which is impervious to light.

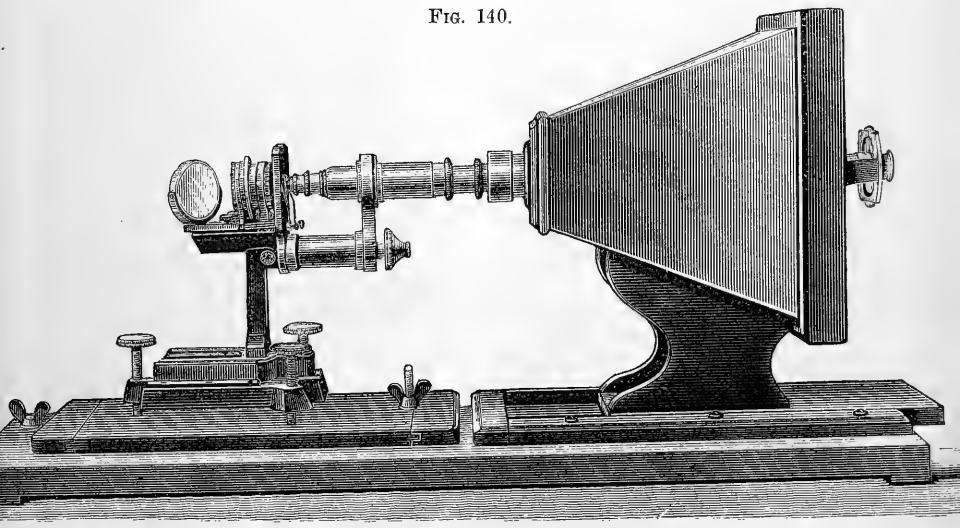
Fig. 139.



For fine-adjustment of the image after a rough focus on the ordinary ground glass, the latter is replaced by a frame with a disc of transparent plate glass having a cross cut with a diamond in its centre. A low power lens is focused on this mark and moved over the plate by a carrier, and the vaguely adjusted picture is then accurately focused.

In the smaller form of camera shown in fig. 140, there is a funnel-shaped non-extending camera which is intended for use with an eye-piece, as without it only small pictures can be obtained; the camera is movable between guides upon the wooden base. The plate-holders are 18 cm. square.

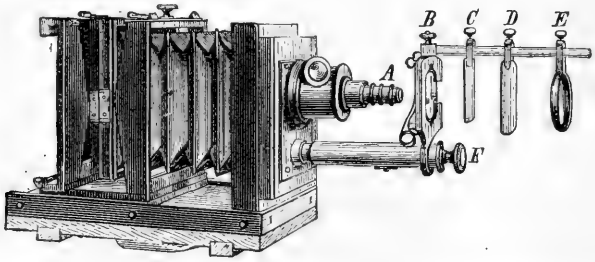
Fig. 140.



For a lamp is used the Siemens gas-burner on an adjustable brass stand and glass globe, described in this Journal, 1886, p. 515; the lamp is said to give an "excellent bright and white light which almost completely supplies the place of good daylight."

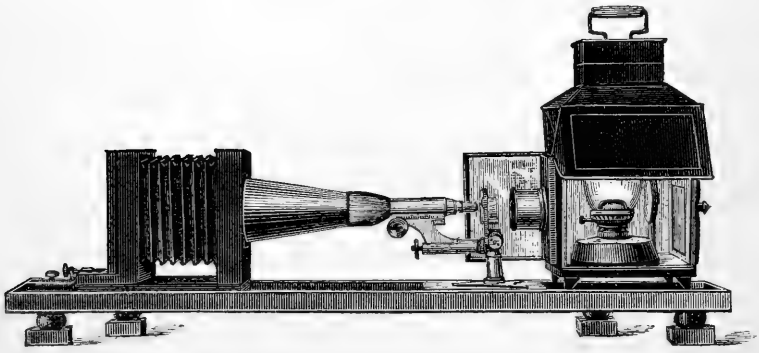
Klönne and Müller attach a standard in front of the camera carrying a stage B which is moved to and from the objective A by the fine-adjustment screw F. The stage has a rod for glass diaphragms C, D, and bull's-eye E.

Fig. 141.



Mr. J. Carbutt combines the camera and Microscope with a lantern in the manner shown in fig. 142.

Fig. 142.

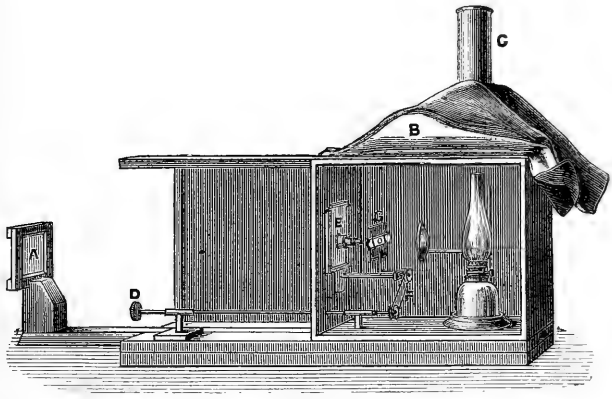


Mr. T. Charters White describes a "simple method of photographing biological subjects without using a Microscope."* The apparatus (fig. 143) consists of an oblong lidless box, laid on its side, and securely screwed to one end of a base-board 2 in. in thickness and 2½ ft. in length. The upper central part of this base-board, about 1 in. in thickness, is made to slide in a dovetailed groove. The end of this sliding part carries the holders A for the plates employed, the holder being an ordinary photographic printing frame. The size of the holder is varied according to the amplification required, and by means of this sliding holder the magnification can be diminished or greatly extended as may be desired. The upper side of the box has an oblong opening cut in it over which a tin chimney C is fixed, thus allowing the lamp to approach or recede from the stage G as may be desirable. Another opening is made in that side of the box which faces the plate-holder, and central with it; this opening is closed by a movable brass plate E, having an adapter with the Society screw soldered into it. Below this plate a support carrying the movable stage is fixed to the side of the box, the stage being moved backwards and forwards by the focusing arrangement D, F. The light is derived from a lamp, burning the purest

* Sep. repr. from Journ. Brit. Dental Assoc., Oct. 1886, 8 pp. and 1 fig.

paraffin oil, in which is dissolved a lump of camphor of the size of a walnut to the ordinary reservoirful; this whitens the flame and renders it more actinic. A plano-convex lens, with the convex side towards the

FIG. 143.

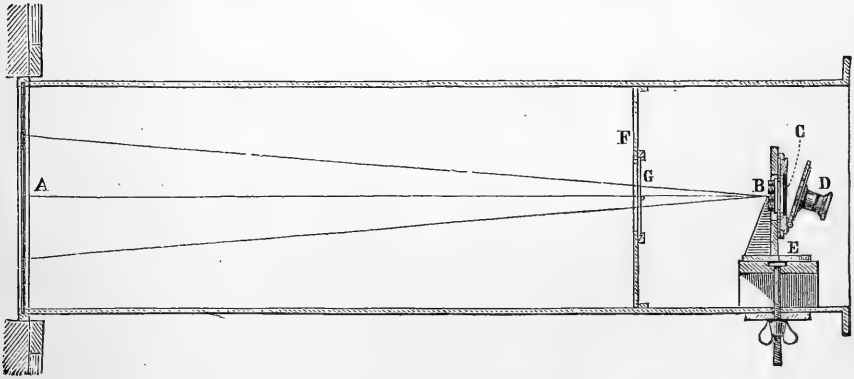


flame, concentrates the light on the object. A curtain of black velvet B falls over the front of the box, shutting all light in, and a shutter cuts off the rays coming through the objective till all is ready for them to fall on the sensitive plate.

Dagron's Microphotographic Apparatus.*—M. Dagron's apparatus for producing microscopic photographs (first used for pigeon despatches during the Franco-German war) is shown in figs. 144 and 145).

It consists of a long rectangular chamber closed at A by ground glass which is brightly illuminated from outside and on the inside of which is

FIG. 144.

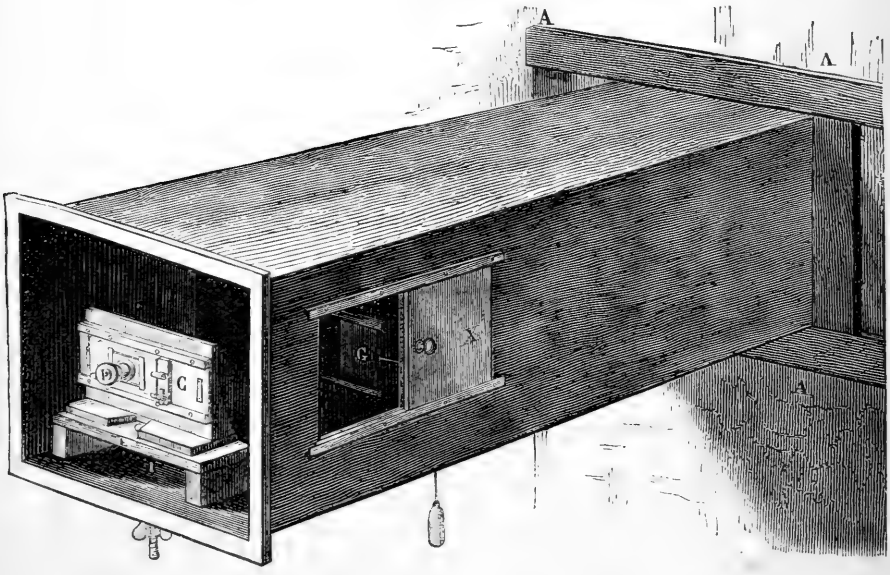


a clamp to hold the negative to be reduced. At the other end of the chamber is the photographic apparatus. At B is a set of 20 microscopic objectives arranged in rows of five, which project images upon a very finely

* S. T. Stein, 'Das Mikroskop und die mikrographische Technik zum Zwecke photographischer Darstellung,' 1884, pp. 315–20 (3 figs.).

ground focusing screen provided with rectangular micrometric divisions; in each of which appears one of the twenty images. At D is hinged a small strongly magnifying Microscope by which the images may be focused, the whole being adjusted by a screw clamp at E. At about a quarter of the length of the chamber from B is a plate F with an opening closed by the sliding screen G held by a counterweight, so that when drawn aside it immediately returns, admitting an instantaneous flash of

Fig. 145.



light. The sensitive plate C receives twenty images at a time and in this way, by five consecutive exposures on adjacent parts, a hundred minute photographs may with ease be taken upon a plate measuring 2 cm. by 15 cm. A lateral opening closed by the sliding door X allows the operator's hand to be passed into the box.

Bousfield's 'Guide to the Science of Photo-micrography.'*—To those who for many years have watched the progress of photomicrography, and who must have often seen brought forward, as novelties and advantages, devices that were adopted years since, it will be very satisfactory to find in Dr. E. C. Bousfield's *brochure* not only a trustworthy guide to the gelatino-bromide process which has been selected, but a real advance in the endeavour to set the principles of the most difficult portion of the subject upon a scientific basis.

The rapid spread of photomicrography amongst microscopists is, doubtless, largely due to the facilities furnished by the use of the dry gelatino-bromide plates, and their sensitiveness to the rays from ordinary artificial

* Bousfield, E. C., 'A Guide to the Science of Photo-micrography; containing Exposure-tables and rules for working,' 69 pp. and Table, 8vo, London, 1887.

light, which enables the microscopist, without very much trouble, to secure at any moment a photomicrograph of the object he is examining, and with only a few minutes' delay; while formerly it was almost necessary to utilize sunlight either with or without an equatorially mounted prism, or some form of heliostat, or the solar Microscope; for the magnesium, oxyhydrogen, and electric lights, though so useful, never obtained more than a temporary claim. Looking to the quality of the results, possibly the palm would be granted to the wet collodion process, as gelatino-bromide negatives often show a fine granulation, absent in the collodion or albumen film, which interferes with enlargement. Still the advantages for general work lie with the dry bromide plate, which is the process the author adopts. All who have endeavoured to obtain the best results with the gelatino-bromide plates have from their great sensitiveness found a difficulty both in the time of exposure and the mode of illumination, and it is to both of these that the author devotes considerable attention, and introduces a more certain way to regulate the exposure according to the non-actinicity of the object, whether due to thickness or colour, to which may be added the difficulty occasioned by alteration in distance between the object and the screen, from a different manufacture of the plates, and from the use of different objectives of the same power. To meet these difficulties the author has constructed a scale or table by which to regulate the time of exposure under these different circumstances. This table of exposures has been ingeniously founded upon the visibility of the figures on Warnerke's sensitometer under the same illumination, and at the same distance of the screen as the gelatino-bromide plate will be placed at, as one of the terms, and used in conjunction with the known scale of the sensitiveness of the plates, either as stated by the maker, or as tested on trial with the same sensitometer, as the other term. These two terms or readings being known, the third, the time of exposure required in seconds for such a plate to be properly exposed, is indicated in the table up to ten minutes. Examples of the use of the scale are given, and every photomicrographer who wishes to work upon this, the most sure method of exposure yet devised, will heartily thank the author for his effort to supply a deficiency, which even long years of experience could not always obviate without the loss of a plate or two.

Dr. Bousfield rightly lays great stress upon the method of illumination when using a paraffin lamp, and points out the correct way of obtaining a brilliant field, or for securing a dark-ground illumination. It may here be noticed, in connection with this latter method of illumination, that stereoscopic photomicrography is passed over in silence, which we should have been glad to see noticed. Part of a chapter is devoted to the use of "orthochromatic" or "isochromatic" plates, with the use of tinted glass between the bull's-eye and condenser, to produce in the negative actinic contrast between the different parts of the object, *inter se*, and the background, and the author furnishes the following rule, "to use such a coloured screen as reduces the colour of the object to a neutral tint," a table being given of the different colours found most useful, and the number of seconds the time of exposure must be increased.

Many years since, Dr. Maddox, instead of using coloured glasses, employed coloured varnishes applied to the back of the slide, thus getting rid of one reflecting surface, and later he tried the use of a small globe filled with various coloured media and placed between the bull's-eye and substage condenser, but nearer the latter, thus obtaining a further concentration of the light.

The author seems to lean to the use of the eye-piece combined with the

objective, though it is still an open question whether better negatives cannot be produced without its use, for the dangers of absolutely correct centering are very great. He also appears rather to prefer the use of the old term microphotography, but he certainly acted wisely in adhering to what is now the standard and well recognised term which, however imperfect, has been admitted since 1864, if not earlier, although the fatherhood has been made somewhat doubtful by the impossibility of finding any printed record of its first use. It has, however, been so generally accepted by the foremost workers since that time, that no other nomenclature can now take its place. Macrophotography was proposed many years since, but never found favour, for it would rather apply to reasonable enlargements, whether from photomicrographs or ordinary negatives, than to the photographic image produced by the Microscope in the first instance.

The photographic use of the new "Apochromatic" objectives with their accompanying "projection" eye-pieces receives a favourable notice, and theory is certainly in their favour.

There are some points in this manual which are a little dogmatic, and others which may be enlarged upon in future editions with advantage to the beginner. The retention of the ordinary brass photographic mount, the lenses being removed, is very questionable unless the screw rims be perfectly blackened, and then if there be a central diaphragm the field may be too much limited. The attempt to photograph different planes by successive focusing, however perfect the fine-adjustment, is open to question, for the different photographed planes when developed must overlie each other and tend to confusion, except with very simple objects. It has been usual to find the most perfect visual focus of whichever plane gives the truest aspect of the whole, and to photograph that, using a rather slow plate, a low angle objective, full exposure, and slow development well restrained.

Hitchcock, R.—**Photomicrography. IX.**
[Sensitizing the paper, printing, mounting, &c.]
Amer. Mon. Micr. Journ., VIII. (1887) pp. 41–4.

(5) Microscopical Optics and Manipulation.

Magnifying Power of Dioptric Instruments.—M. A. Guébhard * has cleared up the disagreement which appeared to exist between theory and practice in regard to magnifying power.

Magnifying power involves a comparison between the apparent size of an object seen with and without the optical instrument, by apparent size being meant the size of the image on the retina. This is proportional to the visual angle (or its tangent), that is to say, it may be measured by $\frac{h}{d}$ where h is the absolute size of an object and d its distance from the first nodal point of the eye. The apparent size may therefore be increased indefinitely by bringing the object near the eye, until the *punctum proximum* or least distance of distinct vision is reached. Defining then the magnifying power as the ratio of the visual angles under which the object is seen, with and without the instrument respectively, when the conditions are as

* Rev. Scientif., 1883, pp. 804–11 (5 figs.). Transl. by G. Fischer, Central-Ztg. Optik u. Mech., v. (1884) pp. 183–8 (6 figs.), 194–7. Cf. also pp. 217–20 (3 figs.).

favourable as possible, we get $P = \frac{H}{D} : \frac{h}{d}$; H being the size of the image and D its distance from the nodal point. Putting $d = 1$, that is, choosing for unit length the distance of distinct vision of the eye under consideration, we may write $P = \frac{H}{h\,D}$. Now if δ = distance between the second principal plane of the instrument and the nodal point, f = distance between the second principal focus and the second principal plane $\frac{H}{h} = \frac{D + \delta}{f}$. Hence $P = \frac{1}{f}\left(1 + \frac{\delta}{D}\right)$.

This is the formula which in different shapes appears as the expression for the magnifying power; but an unjustifiable limitation is generally imposed upon it by rejecting negative values of δ and D. As a matter of fact δ is generally negative. (Supposing the eye at the left-hand side of the page and looking towards the right, the positive direction is here taken as from left to right, negative from right to left, the nodal point being origin.) If δ and D were always positive P would be increased by increasing δ and diminishing D, i. e. by bringing the eye as close as possible to the eye-piece, so that the image is produced at the *punctum proximum*. The fact that this is not done in practice is generally explained on physiological grounds. The eye is withdrawn from the lens, it is said, so as to avoid the prolonged effort of accommodation. M. Guébhard, on the other hand, maintains that accommodation is relaxed simply because in most cases nothing is gained by it. It will be seen that D may have any value between the *punctum proximum* and the *punctum remotum*, i. e. between the greatest and least distances of distinct vision, and the former may be equal to ∞ for emmetropy and even negative for hypermetropy. As regards δ, it is in general physically impossible to bring the nodal point nearer to the instrument than 12 mm., and few instruments have a longer focal length than this, so that δ is generally negative.

The author then discusses the interpretation of the formula in the different cases which may arise according as D is + or −, and greater or less than δ. With the Microscope, for example, where δ is negative, D positive, and δ numerically less than D, δ must be as small and D as large as possible, that is to say, the eye must be brought close to the eye-piece, but accommodation must be relaxed, *so that vision takes place at the greatest, and not, as is generally stated, at the least distance of distinct vision.*

D positive, δ negative, and δ greater than D is the case of the camera obscura, or projection on a screen.

The case of hypermetropy (D negative) is curious; here δ if + must be small, but if negative must be as large as possible, and the instrument will have its greatest power when the eye is withdrawn as far as possible and has the image formed behind it at the greatest distance of distinct vision; the magnifying power continues to increase as the eye is moved farther from the lens, and in this respect hypermetropy is attended with a considerable advantage over every other peculiarity of vision.

The author finally expresses a desire that opticians should determine not only the focal lengths of their instruments, but also the focal positions, so that the actual magnifying power attainable could be calculated from these data and from the physical constants of the eye, instead of assuming, as is generally done, that 250 or 300 mm. represents universally the distance of distinct vision.

Dr. V. Chiusoli points out* that the conclusions of Guébhard can be verified by a simple experiment.

Using the strongest eye-piece and the weakest objective, focus the Microscope upon a coarse object of sharp outline (e. g. hairs). Then, according to Guébhard, the virtual image formed by the eye-piece is at the *punctum remotum* of the eye. Next move the tube suddenly towards the object through a fraction of a millimetre by means of the micrometer-screw; the object at first appears blurred, but after a short effort the details will reappear with their former distinctness. The image in this case has been brought nearer to the eye, and can only be seen clearly again after an effort of accommodation. The movement of the tube must be small, since it will correspond to a large displacement of the image.

In the same way, if the vision be suddenly transferred from one part to another of the same object without any movement of the tube, an effort of accommodation will be necessary, since the different parts of the object do not lie in the same focal plane.

These facts indicate the correctness of Guébhard's conclusions and the error of the impression that the virtual image is always at the least distance of distinct vision.†

Care of the Eyes in Microscopy.‡—Prof. S. H. Gage recommends the microscopist (in addition to keeping both eyes open and using an eye screen if necessary) to "divide the labour between the two eyes, i.e. use one eye for observing the image awhile and then the other."

He considers that "with a Microscope of the best quality and suitable light—that is, light which is steady and not so bright as to dazzle the eyes, nor so dim as to strain them in determining details—microscopic work should improve rather than injure the sight."

KERBER, A.—**Bestimmung der Farbe, für welche die sphärische Aberration zu heben ist.** (Determination of the colour for which the spherical aberration is to be corrected.)

[The author inquires how the aberration should be corrected so that the average spherical aberration of all colours shall equal O, due regard being had to their different intensities; and concludes that this condition is secured when the correction is made for light of wave-length 0·00055, that is, for a ray lying between D and E. It appears, therefore, that this result is practically realized by the correction as it is ordinarily made.]

Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 49–51.

NELSON, E. M.—**Microscopical.**

[Reply to queries on optical tube-length; tests for spherical aberration in objectives, with remarks on the fallacy of the American system of testing; stages, &c.]

Engl. Mech., XLV. (1887) p. 221.

ROYSTON-PIGOTT, G. W.—**Microscopical Advances.** XVII.

[Diffraction, Ancient and Modern.] *Engl. Mech.*, XLV. (1887) p. 93 (1 fig.).

ZECH, P.—**Elementare Behandlung von Linsensystemen.** (Elementary treatment of Lens-systems.) 8vo, Tübingen, 1887.

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* Rev. Scientif., 1884, p. 62. Cf. Zeitschr. f. Wiss. Mikr., i. (1884) pp. 558–9.

† Prof. C. M. Gariel (Rev. Scientif., 1883, p. 789; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 218–9, 3 figs.) gives an elementary proof of Guébhard's results, showing that if the focus lies behind the nodal point the magnifying power increases as the image approaches the eye, and is greatest at the *punctum proximum*. If the focus is in front of the nodal point the magnifying power increases as the image recedes, and is greatest at the *punctum remotum*. If the focus coincides with the nodal point the magnifying power remains constant. Cf. on same subject, Monoyer; Comptes Rendus, xcvi. (1883) pp. 1785–7; Central-Ztg. f. Optik u. Mech., v. (1884) pp. 217–8.

‡ 'Notes on Microscopical Methods,' 1886–7, pp. 8–9.

(6) Miscellaneous.

Relations between Geology and the Mineralogical Sciences.*—Prof. J. W. Judd in his anniversary address to the Geological Society made the following remarks on the Microscope.

"How is it, we may profitably ask, that the biological sciences have made such prodigious advances, while the mineralogical ones have lagged so far behind? We must ascribe the result, I believe, to two causes:—

In the first place, improvements in the construction of the Microscope, and more especially the perfecting of methods of study by means of thin sections, have immeasurably enlarged the biologist's field of observation; histology and the cell-theory, embryology with all its suggestiveness, and many important branches of physiological research, must have languished, if, indeed, they ever saw the light, but for the aid afforded by the microscopical methods of inquiry.

In the second place, the growth of geological and palæontological knowledge has been the leading factor in that profound revolution in biological ideas which, sweeping before it the superstition of fixity of species, has endowed this branch of natural science with the transforming conception of evolution.

Now these two causes, which have done so much for biology, are already working out the regeneration of mineralogy; and I doubt not that the fruits brought forth by the latter science will be equally satisfactory with those of the former.

The application of the Microscope to the study of minerals has proved less easy than in the case of animal and vegetable structures. . . .

The greatest step in advance in connection with the microscopic study of rocks was undoubtedly made, however, when it was shown that transparent sections of minerals, rocks, and fossils can be prepared, comparable to those so constantly employed by biologists in their researches. . . .

I believe that what geology has already done for biology she is now accomplishing for mineralogy; it may, indeed, be instructive to point out how, in every one of its departments, the employment of microscopic methods and the suggestion of new lines of thought are causing mineralogy to develope in just the same directions as biology has already taken before her. In this way we may perhaps best convince ourselves that mineralogy is once more asserting her position in the family of the natural sciences."

The Microscope in the Legal Profession.†—Under this heading the editors of 'The Microscope' write as follows:—

"The importance and usefulness of this great instrument grows with every year. Its valuable service is by no means restricted to the medical profession, whose especial favourite it is. It has interested itself in the varied fields of manufacture, especially in pharmacy and chemistry, where it has become as indispensable an article of furniture as the mortar and pestle to the apothecary; but its orbit has widened and continues to widen with almost every new moon.

"It is, perhaps, not generally known how very useful it has of late years become in the legal profession. A few years ago, when a question arose as to the authenticity of signatures, or suspected alterations in a written instrument (such as deeds, wills or promissory notes), the only means the court and jury had to settle the vexed question was to call in men reputed to be 'experts' in the matter of handwriting, such as bookkeepers, paying-tellers in banks, scriveners and copyists, and take their opinions

* Quart. Journ. Geol. Soc., xlii. (1887), Proceedings, pp. 60–2.

† The Microscope, vii. (1887) pp. 81–2.

for what they were worth. Oftentimes very shrewd judgments were given by such witnesses; but the best opinion in a delicate case was generally submitted as a mere guess or conjecture, with such reasons as the observer had to offer in its support, and smart lawyers generally managed to introduce as many expert witnesses on one side as were offered on the other, and so the jury, instead of being helped, were only the more perplexed over the question which they were sworn truly and correctly to decide. The rule of law being that any *material* alteration in an instrument rendered the entire document void, it will be seen how large interests of contending parties were often suspended on the correctness of the human eye—unaided, it was as difficult a task in many cases as for the observer to tell by a glance the number of fibres in a leaf, or threads in a fabric offered for inspection. In cases of forgery, the freedom or imprisonment of the suspected party was made to turn on the stumbling judgment of unlettered and unskilled men in the jury-box. But to-day, in all such cases the Microscope is summoned into court, and its silent testimony solves the riddle in almost every case. There is no impeaching this expert witness. Call as many Microscopes to the witness stand as may be desired, they all tell the same story—no conflict between them, and the case is settled beyond the possibility of a doubt. In the matter of counterfeited currency the Microscope has become a *vade-mecum* to every modern bank clerk charged with the responsibilities of a receiving teller. If a glance of his well-trained eye awakens a suspicion as to the genuineness of a Government note, he has but to place it under his Microscope and his doubt is made a certainty. His testimony, therefore, in behalf of the Government against the counterfeiting engraver fixes his destiny at once. The relations which the Microscope sustains to medical jurisprudence are none the less important, indeed, they are still more valuable because there they bear upon human life instead of human liberty merely. The criminal whose garments are stained with human blood can no longer relieve himself of a suspicion by saying they were discoloured by the blood of a slaughtered sheep or calf. The Microscope looks down upon them, searches out the corpuscles and renders its verdict at once as to whether the prisoner wears the badge of murder or whether he should go free. Also in all the variety of criminal cases in which poison is suspected and where felonious miscarriage is charged, the Microscope is now a swift and essential witness in ascertaining and settling the exact facts—indeed, it has become as indispensable to the legal profession as to the medical, as might be yet more conclusively here demonstrated had we space in which to expand this article.

"We leave the subject with the remark, that in the whole realm of science there is no instrument yet discovered that, in practical usefulness, can compare with the Microscope, and therefore it is we who are inspired to promote and expand its sphere of science in the cultured and civilized world."

Captain W. Noble and this Journal.—We once asked a paragraph writer for a periodical how it was that he and his brother professionals so frequently wrote such utterly inane paragraphs, about nothing in particular or on such absurdly minute points that they could be of no interest to any human being. His answer was that no one who had not had practical experience in the matter could realize the shifts and difficulties to which the paragraph writer was put. The day of publication came round with the clock and the inexorable employer with equal regularity demanded the prescribed amount of copy, and allowed no delays and no

excuses, so that vacant space had to be filled with nothings if the somethings were wanting.

It is evidently under this influence that Captain William Noble (F.R.A.S. and one of the Fellows of this Society), who writes paragraphs fortnightly for the 'English Mechanic' under the *nom de plume* of "A Fellow of the Royal Astronomical Society," has published a series of notes on this Journal.

Last year Captain Noble apparently wanted to know why the index was not published in December. The obvious way of obtaining the information he wanted, being a Fellow of the Society, was to apply to one of the officials, who would, of course, at once have given it. This would not, however, have supplied any paragraph to fill a vacant space, and accordingly Captain Noble put his inquiry into print, and published it as one of his paragraphs.*

The officials of the Society very properly paid no attention to such an extraordinary proceeding, and "One Who Knows" somewhat unmercifully criticized † Captain Noble for the absurdity of which he had been guilty, and invited him next time to inquire before rushing into print, a suggestion which (perhaps not unnaturally) considerably irritated Captain Noble, who complained ‡ of the "elephantine chaff" to which he had been subjected.

This criticism, nevertheless, made, as it was intended to do, an impression on the worthy Captain, and when this year the index did not make its appearance, he wisely decided that he would inquire before committing himself as he had done in the previous year, and so avoid again falling under the sarcasm of "One Who Knows." When Captain Noble presented himself at the Library to make his inquiry, as his ill luck would have it, the Librarian was absent. What ought any one to do under such circumstances who was really desirous of obtaining an answer to his inquiry? Obviously, if he could not wait until the Librarian returned, he would leave his inquiry as a message or a note, and request a reply to be sent, as it would have been. He would *not* take the first answer he could get—from no matter whom—the more absurd the better—and rush off with it to the printer. Yet this is just what was done by Captain Noble, who, amongst other statements, said § that the result of his inquiry was that he "was informed by the attendant that 'he *didn't know*, but *perhaps* "Mr. Crisp had been too busy to attend to it!'"

The italics in the above quotation are ours, but it hardly requires such marks of accentuation to call attention to the character of the "explanation" which Captain Noble was content to carry away with him for publication!

No notice being taken of this, Captain Noble indited another paragraph, in which he said ‖: "Verily, if there be any foundation for the quasi-explanation vouchsafed to me at King's College, Mr. Crisp must have been oppressed with an amount of business almost appalling to contemplate."

These paragraphs were again criticized by "One Who Knows," who again pointed out ¶ the childishness of Captain Noble's proceeding, and also stated that he had made personal inquiry at the Library of the Society, and that both officials certified that not only did they not give such an answer as alleged, but that no such inquiry, verbal or written, was addressed to them.

This letter irritated Captain Noble still more than before, and induced him to write in terms ** which it would be unfair to print here, as we are sure he regretted his paragraph as soon as he saw it in print. It is never

* Eng. Mech., xlii. (1886) p. 446.
† Ibid., p. 474. ‡ Ibid., p. 489.
§ Ibid., xliv. (1887) p. 560.
‖ Ibid., xlv. (1887) p. 173.
¶ Ibid., p. 201.
** Ibid., p. 219.

wise to write in anger, and still less to print what is thus written, and Captain Noble's letter is a striking example of this. In addition to charges of "impudence" and a reflection on the Council for which there was no foundation, the letter contained the assertion that the period from the middle of February to the middle of April was *four* months, which sufficiently shows the state of mind in which it was written.

The unkindest cut of all came, however, not from the enemy, but from a friend, Captain Noble's own editor, who after very impartially publishing a further letter* from "One Who Knows," closed the discussion with the following remark:—

> "This ends this matter. Our space is too precious to devote to "the endless discussion of the merits or shortcomings of other "publications of no interest to one in a hundred of our readers."

We are sure every Fellow will agree in the very sensible view of the editor, and it is only left to wonder why when Captain Noble had such a plain course open to him, he should have adopted one which exposed him to the well-deserved criticism we have quoted.

The matter, moreover, does not end with the manifestation of its puerility. Never having troubled to obtain an answer to his inquiry, Captain Noble remained in ignorance of the cause of the delay in issuing the index, and hence was led to deal with the matter in a way which he would otherwise not have done, thus exposing himself to be considered not a little inhumane, though we are sure such a charge would in reality be unjust. Whatever his temperament, we are satisfied he would be among the last to, for instance, dance a *pas des fous* at the funeral of his neighbour. We are gratified to know that we have the sympathy of such of the Fellows as are aware of the cause of the delay, and notwithstanding the justification which Captain Noble has given for supposing the contrary, we are sure that if he had only taken the same trouble to get an answer as he did to ask the question we should have had his sympathies also. We only cite the fact to show how more than ridiculous his proceeding has been, whether looked at from the light of his position of a Fellow of the Society or even as an outsider.

In writing these lines we have had no desire to press harshly upon Captain Noble. Though we cannot flatter ourselves that (at the moment at any rate) he will pay much heed to any remarks from ourselves, we have certainly a hope that the expression of opinion from his own editor will have more weight, so that he may not find himself again in such an undignified position. Our object in writing is similar to that which suggested in olden times the fixing of the heads of misguided persons on Temple Bar. They, poor wretches, were beyond the influence of example. The ghastly display was solely intended *pour encourager les autres.* If others are tempted to enter on such a proceeding as that on which we are now commenting, we invite their perusal of this note and ask them to consider the moral it points before launching on the world in print a discussion "of no "interest to one in a hundred of their readers."

BERNARD, J. G.—**Histoire des Microscopes; ce que leur doit la Médecine.** (History of Microscopes; what Medicine owes to them.)

[I. 1. History of simple Microscopes, the solar Microscope, and compound Microscopes, before achromatism. 2. Construction of lenses, achromatism, methods of illumination. 3. Simple and compound Microscopes after achromatism. 4. Accessories. II. 1. What Medicine owed to the Microscope before Schwann. 2. And since Schwann. Recent discoveries, future of medicine.]

iv. and 145 pp. and 1 pl., 8vo, Paris, 1886.

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* Eng. Mech., xlv. (1887) p. 242.

BOYS, C. V.—**On the production, preparation, and properties of the finest Fibres.**
[Fibres less than the 1/100,000 in. in diameter were obtained from quartz.]
Nature, XXXV. (1887) p. 575.

Fraunhofer, Joseph von, zur Säkularfeier seines Geburtstages.
[Sketch of his life, with portrait. Born 6th March, 1787. Died 7th June, 1826. "Achromatic lenses for Microscopes were made in his workshop; a large Microscope completed in 1816 was furnished with a peculiar measuring apparatus to the screw-micrometer, which allowed the diameter of objects to be determined to the 1/100,000 of an inch."]
Central-Ztg. f. Optik u. Mech., VIII. (1887) pp. 73–5 (portrait).
Cf. *Zeitschr. f. Instrumentenk.*, VII. (1887) pp. 113–28 (portrait).

Glass, the New.—Yet other variations of the ludicrous accounts of this glass.
["Professors Abner and Schott have invented a new optical glass, which will be of great value in microscopic photography. It is said that while the ordinary lenses do not admit of distinct reflections beyond 1/500,000 of an inch, this new glass will render 1/204,700,000th of an inch visible."]
Family Doctor, 1887, p. 66.
["As an instance of how a grain of truth may sometimes be transformed into a mountain of error, the Secretary read an item which has been going the rounds of the interior press, and which announced the discovery of a new glass in Sweden, composed principally of boron and phosphorus, of such extraordinary refractive power that lenses made of it would reveal the 1/204,700,000 in."]
Proc. San Francisco Micr. Soc., 13th April, 1887.

Journal of the Royal Microscopical Society—retrospective and prospective.
[Review of this Journal.] *Nature*, XXXVI. (1887) pp. 78–9.

MAYALL, J., Jun.—**Conférences sur le Microscope.** (Lectures on the Microscope.) *Contd.*
[*Transl.* of the Cantor Lectures. See Journal, 1886, p. 869.]
Journ. de Microgr., XI. (1887) pp. 113–24 (12 figs.).

PELLETAN, J.—**Nos Maitres.** Charles Chevalier.
[Memoir and portrait.] *Journ. de Microgr.*, XI. (1887) pp. 177–8 (portrait).

Rogers, W. A., Hon. F.R.M.S.—[Sketch of Life.]
The Microscope, VII. (1887) pp. 45–80 (portrait).

V., O.—**Messrs. Schott & Co.'s new Optical Glass.**
[Remarks on the table of optical data referred to in Journal, 1886, p. 856.]
Engl. Mech., XLV. (1887) p. 249 (in part).

WILLIAMS, G. H.—**Modern Petrography:**—An account of the application of the Microscope to the study of geology.
[Contains a note upon Petrographical Microscopes.]
35 pp., 8vo, Boston, Mass., 1886.

WILLIAMSON, W. C.—**The Microscope and Geology.**
[Abstract of Presidential Address.]
Rep. and Proc. Manchester Sci. Stud. Assoc. for 1886, p. 32.

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Method for Preservation and further Cultivation of Gelatin Cultures.†—Dr. H. C. Plaut preserves gelatin and agar cultivations in the following manner.

If a plate cultivation, the colony is cut out with a fine sterilized knife, and placed on a sterilized slide in a drop of sterilized water to which a trace of glycerin has been added. The slide is then warmed over a spirit-lamp, and a sterilized cover-glass imposed, which is fastened down with some varnish. This procedure will allow the colony to be examined at any time under high powers, and the original condition of the cultivation will be retained for quite a year. If required for cultivation in other media the colony is always available by merely removing the

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Fortschr. d. Med., iv. (1886) p. 419.

cover, and if, instead of water, some nutrient medium be used, anaerobic bacteria can be developed in the chamber.

For test-tube cultivations, after the glass has been washed outside with a 2 per cent. sublimate solution, it is scratched round at the level of the gelatin with a file and then broken off. From the gelatin a colony is dug out with a sterilized knife, and treated as above.

In this way tube cultivations become accessible to the Microscope and to photomicrography. Agar cultivations may be treated in a similar manner, but stronger heating is required. A mixture, however, of equal parts of meat-peptone-gelatin and agar-meat-peptone produces a mass which is fluid at 48° C. and can be preserved at 28° C.

Modification of Koch's Plate Method.*—Dr. R. J. Petri recommends flat double vessels of 10–11 cm. in diameter, and 1–1·5 cm. in height. The one used as the cover, of course, is a little larger. The gelatin, prepared in the usual manner, is poured in so as to form a layer of only a few millimetres thick, and then the cover imposed. A level layer is easily obtained by gentle to and fro movement. Except the edge, every part of the gelatin is accessible to the Microscope. The gelatin dries very slowly, and may be kept damp for a long time by putting several of these small vessels within a large one, with a piece of damp filter paper, and then covering with a bell-jar. These vessels answer very well for agar plates. Numbering the colonies is very simple. The cover is replaced by a glass plate marked out in divisions, through which the position and number of the colonies are noted.

Fig. 146.

Fig. 147.

Method for Cultivating Anaerobic Bacteria.†—Dr. M. Gruber uses a tube made of easily fusible glass; it is about 25 cm. in length, and the wider part about 2 cm. in diameter. The neck, about 5 cm. long, is only 3–4 mm. wide (fig. 146). After having been plugged with cotton wool and sterilized in the usual manner, the lower part or body receives 10–12 cm. of gelatin, introduced with the usual precaution, and is then again sterilized at 100°.

After having been inoculated by the aid of a platinum wire, the cotton-wool plug is rammed down tightly and a caoutchouc plug, with a piece of rectangular glass piping, is fitted into the head. The glass piping is connected with an air-pump, and the air exhausted as far as possible; the residual air is removed by immersing the tube in water at 30°–35°, and boiling. The contents of the tube are prevented from bubbling up by gently heating the junction of the neck and body with a Bunsen's burner. The evacuation and boiling occupy about a quarter of an hour.

* Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 279-80.
† Ibid., pp. 367–72 (2 figs.).

While the boiling is still going on, the neck is heated and melted off (fig. 147). The tube is then laid in a horizontal position and rotated, so as to spread out the gelatin into a regular layer, and care must be taken to allow it to cool gradually. With practice, the whole transaction does not take more than twenty to twenty-five minutes.

The author remarks, that the addition of sugar renders meat-peptone gelatin a more suitable medium for anaerobic bacteria.

The foregoing method is only intended for the cultivation of such bacteria as will thrive at temperatures under 24°–25° C., but the tubes may be filled with agar or fluid media, and used for the examination of the fermentation properties of anaerobic organisms.

New Method for the Cultivation of the Tubercle Bacillus.*—MM. Nocard and Roux advise the use of sterilized serum, which is obtained from the jugular vein of an animal (horse for choice). The blood is passed aseptically into large sterilized bulbs, and then coagulated in fresh water at 10°–12°. The serum is withdrawn with Pasteur's ball-pipettes.

M. Nocard had previously determined that coagulated serum is rendered more suitable for the cultivation of the bacillus by the addition of peptone, soda, and sugar, and the authors now advise the addition of 6–8 per cent. glycerin, which, they state, prevents the formation of the iridescent scum on the surface of the serum from drying and oxidation, and even favours the growth of the bacilli.

Tubercle bacilli were found to grow well in agar-bouillon at 39° if 6 to 8 per cent. glycerin be added to this medium.

The cultivations in media thus prepared grow more luxuriantly and rapidly than by other methods, while they retain the staining and physiological properties characteristic of tubercle bacilli.

Pure Cultivation of a Spirillum.†—Dr. E. Esmarch has succeeded in obtaining a pure cultivation of *Spirillum* from the dried-up remains of a mouse which died of mouse septicæmia. A trace of the remains was inoculated in gelatin, and from this a second tube prepared according to Koch's fractional method.

In the first tube more than 200 colonies of bacteria appeared within a few days. These, which did not liquefy the medium, were of a yellowish-grey colour, and in the course of another fortnight or so assumed a wine-red hue. In the attenuation tube two colonies of bacilli soon showed themselves, and after the lapse of fourteen days four new colonies appeared. These were found to be identical with the red colonies in the first tube. Cover-glass preparations showed that the colonies were a pure cultivation, and consisted of short *Spirilla*.

Cultivated in meat broth, the *Spirilla* were found to flourish best at a temperature of about 37° C., copious development taking place within twenty-four hours. At ordinary temperature eight to ten days were required.

In the original cultivation short *Spirilla* only, with two or three turns, were noticed, but in the broth the number of turns became greater, amounting to thirty, forty, and even fifty. The thickness of curve was always the same, being about double that of the cholera *Spirillum*. The short ones showed lively movements; the larger were either motionless or moved in a slow snake-like way. Cover-glass preparations were stained with the ordinary watery anilin dyes for above five minutes. No flagella were rendered evident.

* Ann. Instit. Pasteur, i. (1887) pp. 19–29.

† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 225–30.

In respect of colour this *Spirillum* was found to differ from other pigment-forming micro-organisms, since access of air was not found to be a requisite, for the red pigment appeared in the deeper layers of the gelatin while the superficial were still devoid of colour. Agar, blood-serum, potato and milk also formed favourable surfaces for the development of this organism.

Examined in hollow-ground slides, the cover-glass of which was supplied with gelatin, the *Spirilla* were found, after ten minutes in the incubator, beginning to show signs of division, and in twenty-four to thirty hours the threads were distinctly separated into segments equal to about three-quarters of a turn, and these segments again, in another twenty-four hours, began to grow so luxuriantly that the colony appeared like one vast coil. Solid media seemed to be more favourable to the production of the shorter forms, and in colonies developed on agar or potato, resting forms, or possibly actual spore formations, became evident. Bright uncolourable spaces, like the spores of anthrax, were seen in cover-glass preparations, and though they could not be differentiated from the rest of the body-wall by staining, they may perhaps be regarded as the resting phase of the *Spirillum*. For when the *Spirillum* was dried on silk threads they were found to be dead in 6–8 days, and no growth took place in gelatin. But the spore-like forms, when dried for five weeks, were capable of developing in broth at a temperature of 52° C. within five minutes.

Experiments on animals which were injected with some of the pure cultivation gave negative results.

For this *Spirillum* the author suggests the name of *S. rubrum*.

New Culture Medium.*—Dr. A. Edington says that a jelly derived from Irish moss is much less opaque than agar-agar, and more nutritious, and is therefore to be recommended as a culture medium for micro-organisms capable of withstanding high pressure. He macerates 2 oz. of the finest selected Irish moss in 18 oz. water, and after leaving it for a night, keeps it in the steam sterilizer at about 212° Fahr. for an hour and a half, stirring occasionally. It is then strained through a felt bag two or three times, when the jelly thus obtained will be found on cooling merely to gelatinize, yet able to withstand a temperature of 87° Fahr. before liquefying; but if it is evaporated it is found to be capable of withstanding a temperature between 122° and 131° Fahr. before liquefying. In this state, if a test-tube be filled with it, it is found to present the appearance of water with only a slight degree of haziness. In order to render this more nutritious, and so better fitted for the requirements of the growth of the generality of micro-organisms, the materials recommended by Dr. Klein may be added, namely, beef-peptone and ordinary cane-sugar. Add to the jelly 2 per cent. of the former and 1 per cent. of the latter, and the result is a jelly almost as bright as nutrient gelatin and infinitely more so than agar, while the simple method of preparation and the price have much to recommend it.

Collecting Urinary Sediment for Microscopical Examination.†—Dr. C. W. Dulles uses a straight glass, and not a conical one as usually recommended, and leaves the urine to settle for 24 hours. After this time he perforates the paper cover of the glass with a pipette employed in the ordinary manner, and leaves the pipette, also covered or plugged, for another 24 hours. He then withdraws it, and uses the first two or three drops for examination.

* Engl. Mech., xliv. (1886) p. 151.
† The Microscope, vii. (1887) pp. 85–6, from Med. News.

ABBOTT, C. A.—**An improvement in the method of preparing Blood Serum for use in Bacteriology.** *Med. News*, 1887, pp. 207–8.

BOLTON, M.—**A Method of preparing Potatoes for Bacterial Cultures.** *Med. News*, 1887, p. 318.

LOCKWOOD, S.—**Raising Diatoms in the Laboratory.** *Journ. New York Micr. Soc.*, II. (1886) pp. 153–66 (2 pls.)

(2) Preparing Objects.

Notes on the Technique of Embryology.* — Dr. H. Henking finds that the eggs of Phalangida can be kept through the winter without getting covered with fungi, and so damaged or even destroyed, by placing them in an ordinary oven on sand or earth kept moistened with distilled water. The usual antimycotics, such as carbolic and salicylic acid and alcohol, are quite unreliable.

Ova are best preserved with boiling water and chrome-osmium-acetic acid, and Perenyi's fluid is also useful, but sublimate, chromic acid, picro-sulphuric acid, 20 per cent. nitric acid are less reliable. Eggs of Phalangida being little penetrable by reagents, it is almost indifferent whether boiling water or a boiling 1/2 per cent. solution of chromic acid be used for hardening.

Owing to the difficulty of staining eggs the author prefers to rupture the shell. This is done by means of two very sharp needles under a power of 40 or 50 diameters and in 70 per cent. spirit. The eggs are previously hardened in 90 per cent. alcohol, and when transferred to the weaker spirit are easily lacerated without damage to their contents. The outer casing only of the shell is broken; this, the more brittle, is covered with a uterine secretion to which foreign bodies are frequently attached, so that there is an extra advantage in removing it. The more flaccid inner shell serves to protect the egg contents.

The eggs are stained *in toto* best with Grenacher's borax-carmine or with eosin-hæmatoxylin, or with Hamann's neutral acetic carmine. If eosin-hæmatoxylin be used, the eggs are washed with a weak alum solution and then transferred to alcohol which is faintly stained with eosin in order to prevent loss of colour. Ova treated with borax-carmine are overstained and then decolorized in slightly acidulated 70 per cent. spirit.

After having been stained and dehydrated the eggs are transferred to a mixture of equal parts of bergamot oil and alcohol for some hours, then to pure bergamot oil, and from this to a mixture of bergamot oil and paraffin. They are next saturated in paraffin at a temperature of 55° C., and when ready are fished out with a spoon and allowed to drop into a vessel filled with cold water in order to cool the paraffin rapidly.

Orientation of the ovum is most easily effected by means of a glass ring 2 mm. high. This is placed on a slide and filled with melted paraffin, in which the eggs are immersed. The slide is then placed under a dissecting Microscope with a power of 40 or 50 diameters, and the egg moved into the desired position by means of a needle heated in a spirit-lamp. Though manual dexterity is required for this operation, it is more simple and easier than to employ the apparatus devised for this purpose. The paraffin block when cool is easily removed from the ring, and is then melted on to a cork.

The treatment of brittle sections, more especially in the case of Arthropoda, is always difficult. The usual methods for obviating the tendency to crumbling are to brush the section surface over immediately before cutting with collodion or with collodion thinned down with ether.

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 470–9.

Dr. Henking, however, finds that ether evaporates too rapidly, and instead uses absolute alcohol for dissolving paraffin. A sufficiently strong but delicate layer is deposited on the section surface by the evaporation of the spirit. If, however, the objects should be extremely brittle, e. g. the eggs of Phalangida, a weak solution of shellac in absolute alcohol and saturated with paraffin should be used. The solution is kept in a stoppered bottle, 8 cm. high, and to the cork are fastened coarse hairs reaching to the bottom of the bottle; by these means fluid sufficient is withdrawn for smearing the section surface.

The removal of air-bubbles, said to occur after mounting in chloroform-balsam, especially when rather thin, may be effected by applying a little pure chloroform at the edge of the cover-glass before adding more balsam.

Method for isolating Epithelial Cells.*—Dr. P. Schiefferdecker, who has employed the process successfully for some years, recommends "Pankreatinum siccum" as an isolating agent for the cells of cuticle. It is a brownish powder made from the pancreas without the aid of chemicals. So much of the powder as will dissolve in cold distilled water is used to the extent of some cubic centimetres. After filtering, pieces of skin are placed therein, and the vessel put in an incubator or some warm place, near but not exceeding the body temperature. Maceration is sufficiently advanced in three or four hours. The pieces are then washed and afterwards placed for preservation in a mixture of equal parts of glycerin, alcohol, and water.

The epithelial cells are easily separated, and their characteristics well preserved.

Demonstration of goblet cells in bladder epithelium of Amphibians.† In his study of the unicellular glands or goblet-cells in the bladder epithelium of Amphibians, Dr. J. H. List used the following methods. For demonstration, nitric acid and silver oxide (1 : 300), and 1/2 per cent. osmic acid for 12–24 hours, with subsequent clearing in dilute glycerin. For hardening, besides osmic acid, 1/4 per cent. chromic acid, 90 per cent. alcohol, and Müller's fluid. Imbedding in paraffin or celloidin. Staining with hæmatoxylin and various anilin dyes—eosin, methyl-green, anilin-green, Weigert's Bismarck brown, nitric acid, rosanilin, dilute Renaut's hæmatoxylin glycerin, and double stains. For isolation, Müller's fluid or 1/2 per cent. osmic acid.

Preparing the Liver.‡—For the examination of the finer structure of the liver-cells Prof. L. Ranvier recommends osmic acid (1–100). He takes pieces of liver (2 mm.) of a freshly killed animal, and leaves them in the fluid for twelve to twenty-four hours. By teasing out, the liver-cells are easily isolated. The excavations on the margins of the cells are not rendered visible by this means, so in order to fill the liver capillaries the author injected the portal vein with a gelatin solution at 30°. The isolated liver-cells were stained either with iodized serum (prepared from the amniotic fluid of a ruminant to which iodine had been freely added), or with "iodide of iodine" (aq. dest., 100; iodide of potassium, 1; iodine crystals in excess).

In order to study the glycogen of the liver, the author employed the following method:—In order to collect as much glycogen as possible in

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 483–4.

† Arch. f. Mikr. Anat., xxix. (1887) pp. 147–8.

‡ Journ. de Microgr., ix. (1885) pp. 3–14, 55–63, 103–9, 155–63, 194–201, 240–7, 287–95, 334–43, 389–96, 438–45, 480–2; x. (1886) pp. 5–10, 55–8, 160–6, 211–4. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 247–51.

the liver-cells, a dog was fed for two days on boiled potatoes to which fat had been added to make them tasty. The animal was then killed, and pieces of the still warm liver were cut with a freezing microtome. The sections were placed in iodized serum and immediately examined. Glycogen was found by this method to be disposed diffusely in the liver-cells, the contents of which had assumed a brown colour. At first the glycogen collects in small irregular masses, but afterwards appears on the cell-surface as lumps stained by the iodine. In sections exposed for some minutes to the vapour of osmic acid the glycogen is fixed within or without the liver-cells without taking on the characteristic wine-red iodine reaction. This staining of the glycogen is unfortunately not permanent, for it begins to disappear in 24 to 48 hours. After leaving the sections in iodized serum for 24 hours, no more glycogen is found.

As an injection mass for the liver vessels Ranvier used gelatin and prussian blue (gelatin, 1·0; prussian blue, 25·0); and also carmin. The gelatin is softened in water, and all the water not imbibed is poured off. It is then dissolved in a water-bath, and to it is added a carmin solution prepared as follows:—Over some carmin No. 40 is poured water sufficient to saturate it. When after standing some hours it has assumed a pappy consistence, ammonia is added drop by drop until the carmin is dissolved. So much of this carmin solution (a very small quantity) is added to the gelatin as will give it the required colour. This mixture is then neutralized by the addition of some drops of acetic acid (1:2 or 3 parts water). Neutralization is shown by the appearance of the wine-red colour. The mass is then filtered through flannel into the injection syringe. (If the temperature of the animal amounts to 36°, there is no diffusion of the injection mass through the vessels, on account of the large quantity of the gelatin.) After cooling, the liver is cut into small pieces of 1 cm. breadth and placed for 24 hours in ordinary spirit. This suffices to render the pieces of liver sectionable.

In order to examine the intercellular substance of the epithelium, the author used the silver method. He exposed the portal vein of a rat just before its entrance into the liver, and in order to remove the blood, injected through a syringe with a silver needle first distilled water, and then after some seconds a silver solution (3:1000). The liver was then placed in distilled water for one or two hours, and afterwards in spirit. On the second day sections were made, mounted in glycerin, and exposed to daylight. After some days they turned brown, and the intercellular spaces became visible.

Prof. Ranvier demonstrates the interlobular connective tissue by hardening pieces of liver in alcohol and staining the sections with hæmatoxylin and picrocarmin. Preparations of the latter were preserved in glycerin to which formic acid was added.

The bile-ducts were injected with Hering's apparatus. With this a mercurial column of 30–40 mm. is advantageous, as with higher pressure slight lacerations of the biliary capillaries occur. The injection mass is prepared by mixing a concentrated solution of the persulphate of iron with a solution of the yellow prussiate of potash. An insoluble precipitate of prussian blue is obtained, but when moistened with water it gradually becomes soluble. A too strong solution should not be used, as it easily precipitates. The injection should be carried out as quickly as possible, and at a low but constant pressure, 40 mm. The animals (rats, guinea pigs, and rabbits) are killed by decapitation, and injected while the liver is still warm. The injection usually only takes one minute. The sections are afterwards mounted in dammar.

In order to show the biliary passages, Prof. Ranvier injected silver solution (1 : 500) into the hepatic duct (in frogs from the gall-bladder) of a recently killed animal (40 mm. pressure). The duration of the injection was three hours. Small pieces of liver were then placed in osmic acid, others in alcohol, and the sections, made in 24 hours, were mounted in dammar or in formic acid glycerin.

The author also employed the "natural" injection. 60 c.cm. of a cold saturated indigo-carmin solution were injected into the jugular of a live rabbit, 15 c.cm. at a time, with 20 minutes' interval between the injections. Ten minutes after the last the animal was killed, and through the portal vein a solution of potassium was injected in order to fix the colouring matter in the biliary canals. Hardening was done in alcohol. Osmic acid is not advisable, as it destroys the blue colour.

Embryonic livers were treated by hardening small pieces for 15 hours in osmic acid, then, after washing, hardening in 40 per cent. alcohol. They were then set in a mixture of wax and oil, and afterwards in elder pith.

When examining the glands of the hepatic duct these were injected with osmic acid (1 : 100). Small pieces were teased out in a physiological salt solution (7 : 1000 aq.). Sections of the hepatic duct stained with picrocarmin were mounted in formic acid glycerin. The glands of the hepatic duct showed up much better with gold chloride than with osmic acid. Freshly expressed lemon juice was injected into the hepatic duct, and 10 minutes later gold chloride 1–100. To reduce the gold, small pieces were kept for 24 hours in formic acid (1 : 3 aq. dest.). The glands were stained a bright violet.

The author then passes to the examination of the gall-bladder (guinea-pig) the epithelium of which he obtained by maceration in iodized serum. Lastly, it may be mentioned that the muscle-fibres of the gall-bladder were demonstrated by injecting therein freshly expressed lemon juice and leaving it therein for five minutes. The gall-bladder is then placed in osmic acid for some minutes, then washed, and the epithelium removed with a brush. Sections stained with picrocarmin show striped muscular fibres.

The Resorcin derivative Phloroglucin.*—Dr. J. Andeer communicates the following interesting properties of phloroglucin or trioxyhydro-benzol. It prevents the coagulation of the blood and other animal juices, keeping them fluid and undecomposed for a long time. In certain fermentations it acts as a deodorizer, but as an antiseptic and antimycotic it is quite useless.

In conjunction with hydrochloric acid it renders bone sectionable in a few hours. (It has, however, no action on elastin or keratin.) The addition of hydrochloric acid to the saturated watery solution of phloroglucin bears a direct relation to the hardness, i. e. to the amount of phosphate, in bone. The acid must be pure, but not fuming. For bones of Batrachia, 5–10 per cent.; of Reptilia and Aves, 10–20 per cent.; of mammals, 20–40 per cent. additions of hydrochloric acid are recommended. The softening of mammalian bones may be hastened by increasing the quantity of hydrochloric acid. After the desired consistence is attained, all trace of acidity must be removed by frequent washing in water, and the preparation treated by any of the ordinary methods of hardening.

The foregoing process has been further elaborated† as follows:—The

* Centralbl. f. d. Med. Wiss., Nos. 12, 33, pp. 195, 579. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 375–6.

† Internat. Monatschr. f. Anat. u. Histol., i. (1886) pp. 350–3.

objects softened by means of phloroglucin and hydrochloric acid are afterwards hardened by one of the recognized methods. As many injection masses are thereby softened, Dr. Andeer recommends, if blood-vessels are in question, impregnating the walls of the vessels with mineral colours instead of injecting their lumen. Injection of solution of ferro or ferridcyanide or sulpho-cyanide of potassium, followed by iron chloride, gives excellent pictures, and the preparations thus obtained are permanent and susceptible of any further treatment.

New Method of Mounting Protozoa in Balsam.*—M. A. Certes describes a new method of mounting Protozoa in balsam, discovered by M. Tempère: the specimens exhibited were of *Ophryoscolex* and *Balantidium* from the paunch of Ruminants. After the organisms have been fixed and coloured they must be passed through alcohol of 36°, 70°, and absolute; the last ought to be renewed at least twice, and should continue to act for about twenty-four hours. The absolute alcohol must then be replaced by pure benzole; a tenth of the alcohol in which the organisms are placed is removed by the pipette, and replaced by the same quantity of benzole; this operation is repeated ten times, at intervals varying from ten to thirty minutes. Care must be taken that the benzole mixes thoroughly; after the last addition it should be decanted, and pure benzole substituted. After twenty-four or forty-eight hours in the benzole, according to the size of the object, a fifth part of Canada balsam dissolved in benzole is added; this is repeated at intervals of from a quarter to half-an-hour; and the organisms may then be preserved in the tubes till wanted, or mounted at once. In mounting care must be taken that each drop holds in suspension a sufficient quantity of organisms.

Microscopical Technique for small Pelagic Objects.†—Prof. J. Brun gets rid of the organic detritus, &c., which accompanies the mud and ooze from which Polycistina, Radiolaria, Globigerina, Foraminifera, and Diatomaceæ are obtained, by heating the dried up mass with weak hydrochloric acid in order to remove the chalk. When the reaction is over the contents of the flask are poured on to a filter and washed. When dry the deposit is treated in a flask with twice its volume of strong sulphuric acid (for guanos 5–6 times this volume of acid is required). After standing some time the upper three-fourths of the acid which dissolves the chitinous débris is decanted off and to the thick black paste is added bichromate of potash in coarse powder until it begins to turn red. By the production of nascent chromic acid the last remnants of organic matter are destroyed; the residuum is then washed at first slowly and afterwards freely and by decantation. The last washings are made with distilled water. The now whitish residue is spread on large cover-glass to dry. Small sea animals may be obtained alive by sweeping them off the surface water in a silk veil fastened to a wire frame. The glairy mass of animals is then at once scraped into a 25 per cent. solution of neutral acetate of potash (solution one quart). The acetate, unlike alcohol, produces no deformity, it prevents decomposition, and is easily removed by washing with water. On the removal of the acetate the mass is treated for several days with cold concentrated hydrochloric acid and the flask frequently agitated. The species are then washed freely and calcined on the cover-glass at a dull red heat. Compact masses of fossil deposit are separated by heating to about 100° and then soaking in a boiling saturated solution of soda sulphate. This salt takes up water as it crystallizes and consequently its dilatation renders the mass

* Bull. Soc. Zool. Fr., xi. (1887), Proc Verb., pp. xix.-xx.
† Arch. Sci. Phys. et Nat., xvii. (1887) pp. 146–54.

friable enough for manipulation after the operation has been repeated once or twice. The mass must never be crushed as a large number of species would be broken.

For sorting and mounting the author uses a low objective (Zeiss *aa* or Seibert No. 1) and a strong ocular. An iron hand-support is fixed to the stage. A pig's or dog's eyelash fixed in a handle is used for picking out. No prism is used as the eye and hand soon become accustomed to the reversed position.

The selected specimens are deposited in a small drop of glycerin-gum lying on the surface of a cover-glass. The gum is made by dissolving 1 grm. of white powdered gum tragacanth in 50 grm. boiling distilled water and then adding to the filtrate an equal volume of pure glycerin. The cover-glasses should be 8–10 mm. in diameter and 1/10 mm. thick.

The selected specimens are arranged on the cover by centering the latter over a circle scratched on a slide. After having been washed with distilled water, the covers are placed in an incubator at 100° (or water-bath) in order to volatilize the glycerin, and hence fix the specimens to the cover.

For mounting diatoms, &c., the author uses balsam of tolu from which cinnamic and benzoic acids have been removed by prolonged boiling in a large quantity of water. It is then dissolved in rectified benzine, filtered, thoroughly dried, and finally dissolved in alcohol or chloroform. When soft the index of this tolu is 1·68, and 1·72 when dry. When the covers are quite dry the tolu thinned with benzine is added and finally a drop of the thicker balsam. The slides are then dried in a stove at a temperature of 60°–70° for an hour or two.

The author decries the artificial (arsenical) media for mounting as the formation of arsenious acid invariably takes place sooner or later and the specimens become useless.

Engelmann's Bacterium-method. — The controversy respecting the value of this method for determining the intensity of the evolution of carbon dioxide is continued by Pringsheim * and Engelmann,† to which Pringsheim ‡ again replies.

Cleaning Diatoms.§—Mr. A. L. Woodward gives the following as an easy and effective method :—

Coarsely powder the diatom-bearing earth, or the dried diatomaceæ, and mix with *bi*-sulphate of potash. Take a porcelain gallipot, about an inch high, and fill it about one-third full of the mixture of diatoms and bi-sulphate ; take the tongs and set it down among the glowing coals in the stove. The bi-sulphate immediately begins to fuse, and bôils up as black as pitch. If the gallipot is not too full it will not boil over, but rises up and sinks back again and again until, as the sides of the pot begin to turn red the boiling mass becomes clear, and the bottom of the vessel is seen glowing hot through it. When the boiling ceases, lift out the pot and let it cool. Brush off any dirt or ashes that may be on the outside of the pot, and then put it in clean, hot, *soft* water, and let the contents dissolve, which they will soon do. Pour off the water, and replace with clean, soft water, repeating this several times to get rid of the acid. Then shake up in a test-tube, let the sand settle, and pour off the diatoms, repeating this process, also, if necessary.

In the author's hands this process has given very fine results, and

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., pp. xc.–xcvi.
† Bot. Ztg., xlv. (1887) pp. 100–10.
‡ Ibid., pp. 200–4.
§ Scientif. Enquirer, ii. (1887) pp. 70-1.

noxious fumes from boiling acids are avoided. The process was originally suggested by Mr. G. C. Morris, of Philadelphia; he, however, suggested the use of a platinum crucible, which is costly. The porcelain gallipot answers every purpose, while the expense is merely nominal.

Preparing Bacterial Material for Transmission by Post.*—Dr. G. Marzi has devised the following method for transmitting specimens of bacterial material by post, &c.

Square pieces of gelatin leaf, about 14 mm. broad by 25 mm. long, are soaked for five minutes in a 1 per cent. solution of sublimate in absolute alcohol. These having been repeatedly washed in alcohol, are placed under a sterilized bell-jar to dry. A small quantity of the bacterial material (a pure cultivation, blood serum or the like) is then spread with a platinum wire on the gelatin leaf near the edge. When the preparation is quite dry it is rolled in sterilized tinfoil, put in a case and labelled. Two specimens should be sent, one for microscopical examination, the other for cultivation.

The receiver, after having unrolled the tinfoil, rubs the gelatin disc on the surface of a cover-glass moistened with sterilized water. To the cover, the greater part of the bacterial material adheres, and can be used at once after staining, for microscopical examination or for cultivation purposes.

If it be certain that the culture be pure and that the microbes are alive, the second specimen can be used for cultivation on gelatin; if not perfectly pure, the isolation method must be adopted.

Technical Method of Diagnosing Gonococci.†—M. G. Roux recommends the following method of determining the absence or presence of the *Gonococcus* of Neisser, which has hitherto been very difficult. When it is attempted to detect micro-organisms in any organic liquid, the method of double coloration of Gram is generally adopted, that is, after the preparation has been dried and stained by methyl-blue or gentian-violet, it must be submitted to the iodized iodine liquid of Gram, which possesses the property of fixing the anilin colours on the microbes exclusively; the preparation is then decolorized by alcohol, treated with distilled water, and re-stained with eosin; although this method generally succeeds with secretions, it always gives a negative result if *Gonococcus* alone is present. In doubtful cases, then, if *Gonococci* have been recognized on staining by gentian-violet or other reagent without the addition of alcohol, it is only necessary to adopt the method of Gram; if, then, all the cocci disappear they are those of Neisser; if, on the contrary, they or any remain, there must be doubt as to the blennorhagic nature of the secretion.

Preparing Crystals of Salicine.‡—Dr. F. L. James writes as follows:—"Some years ago the writer, after finishing a lot of slides of various crystals for examination under the Microscope, poured a few drops of a solution of salicine on a piece of window glass, and left them to crystallize. Some days afterwards, on examining the glass, he was surprised and delighted at the gorgeous beauty of the crystals. Two of the drops had crystallized so that the glass could be cut away into slides and mounted. These two specimens have been shown annually at the meetings of the American Society of Microscopists, and have been seen and admired by thousands, not one of whom had ever seen their equal. Words utterly fail to give any idea of their splendour. 'Nothing,' said a gentleman at Cleveland, 'short of the Pearly Gates can compare with them.'

Although during the past four or five years I and my students

* Riforma Medica, 1886, No. 21.
† Comptes Rendus, ciii. (1887) pp. 899–900.
‡ St. Louis Med. and Chirurg. Journ., li. (1886) pp. 280–1.

have made many hundred and even thousands of attempts to duplicate these results, up to very recently these two slides have remained unique. After the Chautauqua meeting, where they were again the centre of admiring crowds, I commenced a series of systematic experiments, discarding old methods altogether, and can now announce that I have found a method by which I can get slides, even more magnificent, with absolute certainty; and I have now in my cabinet a dozen, any one of which distances in every respect the old preparations, magnificent and beautiful as they were. I am continuing my experiments with other crystallizable materials, and when they are completed will explain the methods by which the results are obtained. I will say, however, that the size and the form and method of growth of all crystals yet experimented with are modified by the temperature at which crystallization takes place; the degree of saturation of the mother liquor or solution; the position in which rests the slip on which crystallization progresses; the medium used for solution; and, finally, by the material used for retardation of crystallization."

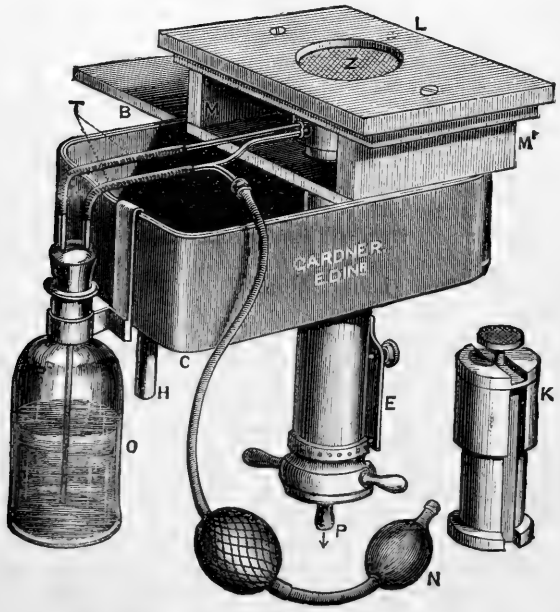
LATHAM, V. A.—**Practical Notes on preparing Palates of Molluscs, Snails, &c.** *Scientif. Enquirer*, II. (1887) pp. 87–9.

TURNER, W. B.—**Desmids.** [Directions for preparing.] *Trans. Leeds Naturalists' Club*, 1886, pp. 16–8.

(3) Cutting, including Imbedding and Microtomes.

Rutherford's Combined Ice and Ether-spray Freezing Microtome.*—Prof. W. Rutherford's well-known microtome is now adapted for freezing

FIG. 148.



by means of an ether-spray apparatus, as well as by the original ice and salt method.

* Lancet, 1885, i. pp. 4–6 (2 figs.).

Fig. 148 shows the instrument as arranged for the spray. The gum-imbedded object placed on the zinc plate Z is frozen by means of a spray of anhydrous ether contained in the vessel O having the tubes T. The superfluous ether runs down through the tube P to a collecting bottle. The spray-tubes are fixed in a slot under Z, so that they are easily removed if required. Instead of the hand-bellows N a pedal pump can be employed. There is an indicator at E. The zinc plate Z is insulated from the surrounding metalwork by means of a vulcanite casing. When used with ice, the glass plate L, the supports M and M′, and the spray apparatus are removed; Z is unscrewed, and replaced by the plug K. The glass plate L is next fitted on the brass plate B, and then the instrument is ready for use. When the box C is filled with the ice and salt mixture the tube H is kept plugged until the box becomes quite full of water. The gum solution is poured into the well and the object immersed therein. The mouth of the well is then closed by means of a guttapercha sheet fixed down by a flat leaden weight, and the whole instrument wrapped up in flannel until the freezing is complete.

A special advantage claimed for this instrument is the facility with which delicate sections are removed from the knife into water, or at once on to the slide.

The knife required for this instrument is of a special construction, and when used is pushed over the glass plate and across the well at a right angle. Hence the knife does not remain sharp very long.

Machine for cutting Rock-sections.*—The machine devised by Dr. H. Rauff does not differ in principle from those which are ordinarily used, but it is provided with adjustments of a new form, by which the rock-specimen may be firmly fixed in any desired position with respect to the cutting-disc. The construction is that of an ordinary turning-lathe, the disc being worked by a treadle and grooved flywheel, while the specimen is held in a support which slides along the horizontal slot of the lathe-bench, and is clamped by a nut from below like the movable rest of a turning-lathe. The rock is held, not by cement as is generally the case, but in a vice capable of holding large fragments: the block which carries this vice is provided with two horizontal rectilinear sliding movements at right angles to one another, one of which is worked by a screw-worm and handle, and the other by a weight acting over a pulley, which keeps the rock in continual contact with the cutting-disc. In addition to these movements the vice-piece can also rotate about a vertical and horizontal axis, and the plate to which it is attached is adjusted and fixed by four levelling-screws. The bearings of the axle and the various parts of the machine are made so massive as to insure greater stability than such machines generally possess.

Sections of Chitinous Organs.†—Herr P. F. Breithaupt, in his investigations into the structure of the bee's tongue, made use of eau de Labaraque (subchloride of potassium), which, after long-continued treatment, dissolves chitin, while it has a preservative action on the neighbouring tissues. The concentrated solution of eau de Labaraque was diluted with three to four parts of water. After washing with water and 35 per cent. alcohol the preparations were hardened by absolute alcohol, cleared up in oil of cloves and imbedded in Canada balsam; those which were adapted for cutting were, after treatment with oil of turpentine, imbedded in a

* Verh. Naturhist. Ver. Preuss. Rheinlande, xliii. (1886) Corr. Bl., pp. 130-9 (3 figs.).

† Arch. f. Naturgesch., liii. (1886) pp. 53-5.

paraffin wax mixture, in which were three parts of white wax to one of soft paraffin. The objects were gradually cooled, and sections were made at a temperature of at least 17° R. Schanze's microtome, which is regulated to cut sections from 1/100 to 1/150 mm., was used, and the objects were fixed by Giesbrecht's method. In cutting sections it is important to begin at the hinder end or to follow the direction of the hairs.

Orienting Objects in Paraffin.*—Mr. E. A. Andrews has improved the method of Dr. Selenka† for keeping paraffin melted while the contained small objects are being arranged under the Microscope in any desired position, and then rapidly cooling the paraffin without disturbing the position of the objects.

FIG. 149.

Finding it difficult to make tubes such as Prof. Selenka described, which should be of such shape as to admit of removing the hardened paraffin readily, and at the same time with depressions of sufficient size for any but very minute objects, Mr. Andrews made use of the following simple device, which, though more clumsy than the tube of Selenka, can be used for objects 1 mm. long and much larger, while giving a block of paraffin of very regular shape and with rectangular sides.

A common flat medicine bottle is fitted with a cork through which two tubes pass, or, if the mouth is small, one tube may be fastened into a hole drilled into the bottle. One of these tubes A is connected with hot and cold water; the other B is a discharge-pipe for the water entering the bottle by A, and raising or lowering its temperature as warm or cold water is allowed to flow in. On the smooth flat side of the bottle four pieces of glass rods or strips are cemented fast, so as to inclose a rectangular space C, which forms a receptacle for the melted paraffin. As long as the warm water circulates through the bottle the paraffin remains fluid, and objects in it may be arranged under the Microscope by light from above or below, and can be oriented with reference to the sides of the paraffin-receptacle or with reference to lines drawn upon the surface of the bottle. When the cold water is allowed to enter in place of the warm, the paraffin congeals rapidly, and may be easily removed as one piece. The discharge-pipe should open near the upper surface of the bottle, to draw off any air which may accumulate there.

Orienting Small Objects.‡—It is frequently a very difficult matter to properly orient small objects, especially spherical eggs, so that sections may pass through any desired plane. In working on the embryology of the common shrimp, Mr. J. S. Kingsley found the following process very convenient:—Impregnation with paraffin is accomplished in the usual way, and then the eggs (in numbers) in melted paraffin are placed in a shallow watch-crystal. They immediately sink to the bottom, and then the whole is allowed to cool. The crystal, glass upwards, is now placed on the stage, and the eggs examined under a lens. In this way one can readily see exactly how any egg lies, and then with a knife it may be cut out with the surrounding paraffin, and in such a way that it can readily be fastened to the block in any desired position. After all which have been dropped in a

* Amer. Naturalist, xxi. (1887) pp. 101–2. † See this Journal, 1885, p. 1086.
‡ Ibid., p. 102.

suitable position are thus cut out, the paraffin is again melted, and after stirring the eggs the cutting out is continued as before.

Method for Reconstructing Small Microscopic Objects.*—Dr. N. Kastschenko's method depends on the principle of obtaining two intersecting and perfectly smooth surfaces which he terms definition planes. In respect to the reconstruction of the object, he follows previous methods, especially that of His. He imbeds his object in paraffin and stains the surface of the block with lampblack dissolved in about ten times its bulk of turpentine. The stained block *a* is in its turn imbedded in paraffin (fig. 150). The accuracy of the surfaces is obtained by means of the machine (fig. 151)

Fig. 150.

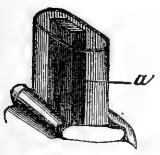
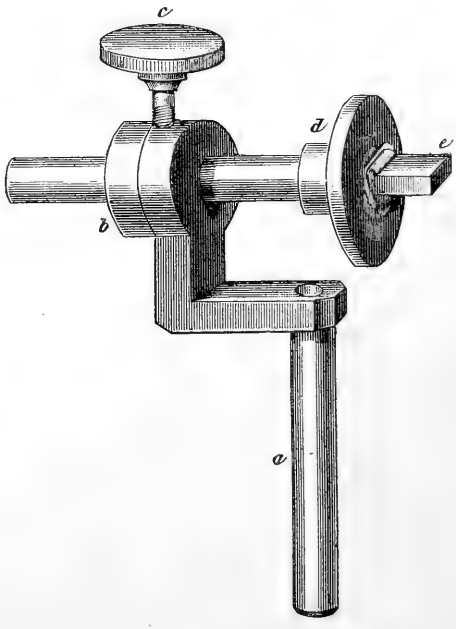


Fig. 151.



invented by the author, and intended to be adjusted to the Schanze microtome. It consists of a bar *a* bent twice at a right angle: through the ring *b* at its upper end runs a bar, terminated by a circular disc *d*, to which the preparation *e* is attached: the horizontal bar is fixed in the desired position by the screw *c*.

The construction of the object is effected in the usual manner, and is divisible into two chief groups, surface construction and serial construction. For the former, transparent material, such as glass, wax-paper, are employed to obtain a figure from the superimposed sections. Under some circumstances the camera lucida may be used to draw successive sections on the same paper. For surface construction, longitudinal sections are the most suitable.

In serial construction the reproduction of the object is easily obtained by the aid of the definition lines, which are made in every drawing of a section in the same position as far as regards the *definition surface*, but which will of course vary in reference to the parts of the object (cf. figs. 152 and 153, *e f*, *g h*). Axial revolution of the object renders reconstruction more complicated ; in this case it is unavoidably necessary to draw a circle with the same radius in each section, so that its position in relation to the definition surfaces shall remain the same for every drawing (figs. 152 and 153). Hence the position of the various organs of the object which lie in a

* Arch. f. Anat. u. Physiol.—Anat. Abtheil., 1886, pp. 388-94 (1 pl.).

definite plane is projected upon the corresponding diameter of the described circle.

The employment of definition surfaces renders possible not only accurate reconstruction but also determines the change of form of the whole

Fig. 152.

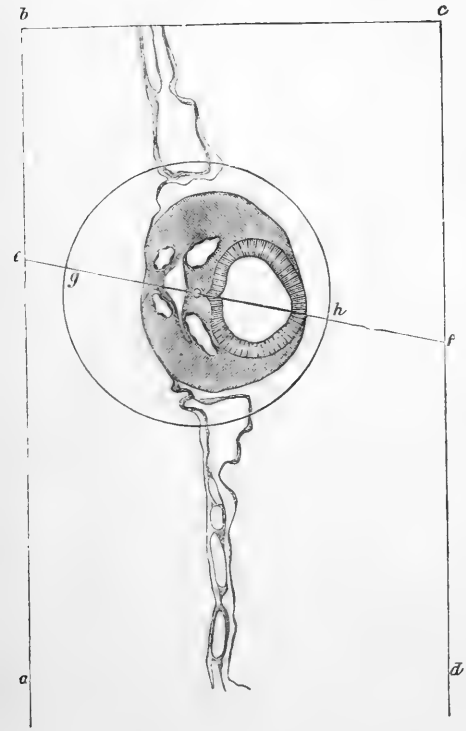
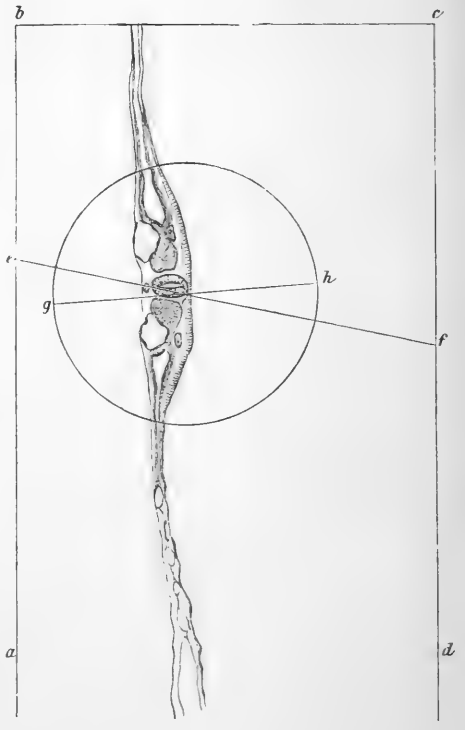


Fig. 153.



object, the position of its various parts in the successive sections, and even allows the size of the angle about which the object has turned to be calculated.

Reeves, J. E.—**How to work with the Bausch and Lomb Optical Co.'s Microtome, and a method of demonstrating the Tubercle Bacillus.**
27 pp., 8vo, Rochester, N.Y., 1886.

(4) Staining and Injecting.

Absorption of Anilin Pigments by living Vegetable Cells.*—Dr. W. Pfeffer continues his researches on this subject, using for his experiments solutions of one part in a million of the pigment, and in the case of methyl-violet, one part in ten millions. If the pigment which enters the cell remains unchanged, the concentration must remain the same inside and outside the cell, and no staining could be detected under the Microscope. Any tinging of any part of the cell must be due to a chemical change in the pigment;

* Unters. Bot. Inst. Tübingen, ii. (1886) pp. 179–331. Cf. this Journal, *ante*, p. 172.

and if the new compound is also coloured, and either not or only slightly diosmotic, a perceptible accumulation of pigment takes place in the cell. The absorption and storing up of the anilin pigments is not connected with the vital activity of the cell. The following are absorbed by the living cell, viz. methyl-blue, methyl-violet, cyanin, Bismarck-brown, fuchsin, saffranin, methyl-orange, tropæolin, methyl-green, iodine-green, Hoffmann's violet, gentian-violet, rosolic acid. No special staining of the cell-nucleus or chromatophores was observed in any case, but a tinging of the protoplasm with all except methyl-blue, and an accumulation in the cell-sap with all except rosolic acid; the microsomes, granules, and vacuoles were also stained. No absorption appeared to take place of nigrosin, anilin-blue, marine blue, anilin-grey, eosin, or Congo-red.

In a subsequent communication,* Dr. Pfeffer states that methyl-blue is largely absorbed by the living cell, a definite chemical compound with tannic acid being formed. The pigment subsequently either remains in the cell or passes out into the surrounding water. This exosmose can also be brought about by the action of citric acid. He suggests that these phenomena may illustrate the analogous phenomena exhibited by the food-materials of plants.

Modification of Weigert's Method of Staining Tissues of the Central Nervous System.†—Dr. N. M. Gray hardens specimens in Müller's or Erlicki's fluids, and then transfers directly to 70 per cent. spirit, and afterwards to absolute alcohol for several days. They are then soaked for one or two days in a mixture of equal parts of ether and absolute alcohol, and next transferred to a solution of celloidin, and eventually imbedded in celloidin on cork. The pieces, still fastened to the cork in the celloidin, are immersed in a solution of neutral acetate of copper (a saturated filtered solution of this salt diluted with an equal volume of water), and allowed to remain in an incubator at 30° or 40° C. for one or two days. The specimens become pea-green after the copper treatment, and the celloidin of a blueish-green. They may now be preserved in 80 per cent. spirit indefinitely. After having made sections, which must still be kept clear of water, they are immersed in the hæmatoxylin solution, the formula for which is as follows:—Hæmatoxylin (Merck's, in crystals) 1 part, absolute alcohol 10 parts, water 90 parts. Boil twenty minutes, cool and filter, and to each 100 parts add 1 part of a cold saturated solution of lithium carbonate. The time for staining varies; in general, the larger, the sooner the result: for cord sections 2–3 hours are enough; for brain sections twenty-four hours are required to colour the very fine fibres of the cortex.

After staining, the sections, now black, are decolorized by immersion in the following fluid:—Borax 2 parts, ferricyanide of potassium 2½ parts, water 100 parts. For cord, half to several hours; for brain sections longer.

From this solution, the sections are transferred to water and well washed, then to 80 per cent. spirit, then absolute alcohol, then cleared up in xylol or creosote, and mounted in xylol- or benzole-balsam.

Modification of Golgi's Method for Staining the Central Nervous System.‡—Signor Tal modifies Golgi's method as follows:—The small pieces of the central nervous system previously prepared by Golgi's method (hardening in bichromate of potash, and subsequent treatment with a 1/2 per

* Ber. Deutsch. Bot. Gesell., iv. (1886) Gen. Versamml., p. xxx.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 31–2, from Med. News, 1886.
‡ Gazz. Ospit., vii. (1886) No. 68.

cent. of corrosive sublimate), are placed in a solution of sulphide of soda. The mercury, already reduced from the sublimate, is changed into sulphide, and the preparations become blackened. The tissue, which has not undergone the influence of the foregoing reaction, is stained with a solution of Magdala red, which gives extremely beautiful pictures. Even Golgi's nitrate of silver method is improved by after-treatment with sulphide of soda.

China-Blue as a Stain for the Funnel-shaped Fibrils in Medullated Nerves.*—Signor C. Galli has succeeded in staining with China-blue the spiral or funnel-shaped fibres of the myeline sheath of peripheral nerves, about the existence of which there was once considerable dispute.

The procedure, which is very simple, is as follows:—The sciatic nerve, carefully cut out from a recently killed animal, is placed in Müller's fluid for eighteen to twenty days. It is then cut up into pieces 5 or 6 mm. long, and these pieces are placed for one or two days in a mixture of one part Müller and two parts water. They are then cut up lengthwise, and immersed in a few drops of glycerin to which glacial acetic acid has been added in the proportion of one or two drops of acid to 1 or 2 c.cm. of glycerin. In this they remain for fifteen to twenty minutes, according to the greater or less acidity of the glycerin. The pieces are then placed in ordinary spirit, where they lose the excess of their colour, and are then coarsely teased out. They are next dehydrated in absolute alcohol, and then cleared up in oil of turpentine. Lastly, a small piece is carefully teased out on a slide and then mounted in dammar.

From the author's description, it would seem that the staining is somewhat diffuse, so that sometimes the funnel-fibres are obscured by the darker stain of the other constituents of the nerve, especially the sheath of Schwann. The blue stain colours the axis-cylinder, the myeline sheath of Schwann's membrane, as well as the funnel-fibres and the primitive sheath nuclei. From the illustrations given by the author, we gather that the axis-cylinder and the nuclei are the less colourable parts.

New Staining Method for Sections.†—Dr. H. Kühne thinks that it is advantageous to pass sections through a concentrated watery solution of oxalic acid and then thoroughly wash them before staining. For this purpose the author uses watery solutions of the dyes which in the case of fuchsin he combines with anilin or thymol water; of methylene blue with a 1 per cent. watery solution of ammonia carbonate; of violet with anilin or thymol + ammonia carbonate. Differentiation is not effected with acids and alcohol, but the sections are first dehydrated in absolute alcohol, to which some of the first used dye has been added.

Differentiation is attained by means of acid stains, of which fluorescin is the most universally applicable. This is dissolved in oil of cloves, and from the mixture the sections are passed through turpentine to xylol and then to xylol balsam.

Double Staining with Orcin.‡—Dr. O. Israel has introduced a new dye, orcin ($C_4H_7NO_6$), to microscopical and especially to bacteriological technique, being suitable for most bacteria as well as for various tissues. It is a vegetable dye which unites in itself the staining properties of the basic and acid stains, and also the combination of two contrast colours.

If sections of actinomycotic tissue be placed in a saturated acetic acid solution, the fungus assumes a dark Bordeaux-red hue, which is the more

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 465–70 (1 pl.).
† Zeitschr. f. Hygiene, i. (1887) p. 553.
‡ Virchow's Arch. f. Path. Anat. u. Physiol., cv. (1886) p. 169.

pronounced if the surrounding tissue be quite decolorized with alcohol. If, however, decoloration be not carried so far, it will be found that in addition to the fungus, the nuclei of the surrounding tissue are blue and the protoplasm red. As glycerin extracts the blue colour, preparations must be mounted in balsam.

As dehydration conducted in the ordinary manner would deprive the sections of colour, it is necessary, after having washed in distilled water, to pass rapidly through absolute alcohol to the slide, where the excess of spirit is to be quickly blotted up. A drop of thick cedar-oil is then added, and as this soon hardens, balsam need not be applied. Thus prepared, specimens have kept well for five years.

Double Staining with Echein-green and Carmine.*—Mr. J. D. Beck states that he has met with splendid results by a combination of echein-green (an acid dye) and carmine. He first stains the sections with the echein-green for five seconds to ten minutes. They are then washed in distilled water from 150° to 212° Fahr. for two to twenty minutes. If time allows, cold water acting for a longer time acts as well. Alcohol first of 60 and then of 95 per cent. hastens the process. The object of the foregoing is to remove all acidity before staining with carmine. The sections are tested for acidity by allowing some water from the slide on which a section is placed to drop on the tongue, or to add some carmine to the slide water and examine under the Microscope to see if any precipitate occurs when ammonia carmine is added. If all traces of acidity be removed, the carmine staining may be proceeded with.

When sections have a feeble affinity for green, the author mounts in the following medium:—White sugar syrup 1 oz., pure glycerin 10 to 30 drops; mix thoroughly. When stained the section is first cleared in pure glycerin, the surplus of which is washed off with water; the latter is evaporated and then the syrup added.

Stained Permanent Preparations of Cover-glass Cultivations.†—Dr. F. Lipeż's method for preparing and staining cover-glass preparations suitable for observing under high powers the developmental changes in micro-organisms, consists in first obtaining a thin layer of the nutritive medium previously inoculated to any desired degree with the micro-organism to be examined. The medium is kept in a water-bath at a temperature of 25° or 40° C., according as gelatin or agar is used. With this the surface of the cover-glass is moistened and the superfluous matter drained off with blotting-paper. A film about 0·08 mm. thick is thus obtained. The covers are then placed in a moist chamber or in an incubator, and are then withdrawn at definite intervals. They are dried (best over strong sulphuric acid), stained, decolorized, and mounted in balsam.

The most difficult part of the operation is to decolorize the gelatin or agar without removing the stain from the organisms. The behaviour of the various dyes and of the nutrient layers is very different, but the author mentions, provisionally, that methyl-green is easily removed, and that alcohol and carbonate of potash may in a measure be relied on for decolorizing. Again, some care is necessary to prevent the "fluidifying" bacteria from being washed away, while of other varieties many stick firmly to the cover even after the medium has been removed.

New Methods of using Anilin Dyes for staining Bacteria.‡—Mr. E. H. Hankin premises that in the methods he describes care must be given

* The Microscope, vii. (1887) pp. 69–71.
† Centralbl. f. Bacteriol. u. Parasitenk., i. (1887) pp. 402–3.
‡ Quart. Journ. Micr. Sci., xxvii. (1887) pp. 401–11.

to the hardening of the sections; Müller's fluid must always be used, and the tissues cut into very small pieces.

For the first method the materials required are (1) a strong watery solution of methyl-blue or Weigert's anilin oil solution, (2) a saturated alcoholic solution of eosin, (3) a pipette, (4) absolute alcohol kept as free as possible from water, (5) benzine and clove-oil in equal parts, with an addition of absolute alcohol, sufficient to dissolve the turbidity which appears on shaking these reagents together, (6) fresh and nearly colourless oil of cloves, (7) benzine, xylol, or cedar-oil. The sections, on being taken from spirit, are placed in the methyl-blue solution, and eosin is immediately dropped in from the pipette—about equal parts should be used. The sections should be at once removed to absolute alcohol, and, after a few seconds' shaking, placed in the benzine and clove-oil mixture; as soon as the effects of the eosin begin to be apparent, they should be placed in benzine and mounted. The whole process does not take more than a minute. Sections thus stained show the bacteria and the nuclei blue, the eosin stains the red blood-corpuscles orange, and the background of the tissue is of a rose-red tint.

Successful results were also obtained with watery solutions of Spiller's purple; as soon as the sections are placed in it an equal bulk of alcoholic Spiller's purple must be dropped in from a pipette; the sections are then dehydrated in absolute alcohol as quickly as possible, and removed to the benzine and clove-oil mixture. When cleared, the sections are placed in eosin dissolved in oil of cloves, which stains the background red, and turns out the excess of Spiller's purple; the sections are then washed in oil of cloves, passed through the benzine and clove-oil mixture, placed in benzine and mounted. A somewhat similar method was adopted with fuchsin or gentian-violet as the staining reagent.

In all these methods, advantage is taken of the well-known fact that benzine does not dissolve, and therefore fixes the anilin dyes; one of the advantages of placing sections in benzine before mounting is that any residue of clove-oil is removed. Some of the methods used give results which promise to be very permanent.

Staining Cover-glass Preparations of Tubercle Bacilli.* — Dr. H. L. Tohnan obtains very satisfactory results by the following modification of the Weigert-Ehrlich method.

(1) Anilin oil 30 drops, distilled water 3 oz. Shake vigorously for five minutes and filter.

(2) Saturated solution of fuchsin in 93 per cent. alcohol. Mix together in a watch-glass 2 dr. of No. i. and 15 drops of No. 2. Upon this drop the cover-glass, whereon the sputum has been applied in the usual manner, and allow to stain for twelve hours. Decolorize in 33 per cent. nitric acid until the colour has *almost* gone. By the use of heat the staining may be effected in from 30–60 minutes; but in this case the acid solution is not stronger than from 5 to 15 per cent.

The author recommends the following for preserving, and at the same time staining sputum. The patient puts the sputum first coughed up in the morning into a mixture of anilin oil solution, as above, 2 dr.; fuchsin stain 20 drops, carbolic acid 10 per cent. solution 5 drops.

This mixture is to be prepared fresh, and the sputum left therein for at least twenty-four hours.

This method, as far as time goes, is not to be compared to the Neelsen-

* The Microscope, vii. (1887) pp. 83–4, from 'Medical Record.'

Glorieux method described in this Journal, 1886, p. 537. The latter operation only takes five minutes altogether.

Staining of Syphilis and Tubercle Bacilli.*—Dr. B. Bienstock relying on the assumption that smegma bacilli owe their resistance to decoloration to a coating of fatty matter, bred various kinds of bacilli (of fæces, of green pus, of anthrax, and of typhoid bacillus) in butter-gelatin. According to his expectation, he found that the bacilli thus cultivated show the same resistance to acids as do those of syphilis and tubercle. The material employed was 100 grm. of agar-gelatin mixed with about 20 grm. of boiled butter. The mass having been sterilized is placed in test-tubes and frequently shaken up and the test-tubes put in an oblique position, in order that only a small drop of butter may find its way to the top of the gelatin when it sets. The bacilli grown in the butter-layer were found to possess the staining property alluded to, but not those found in the layers below or above.

The author explains these facts by supposing that the fat-envelope permits the passage of colouring matter but resists the penetration of any decolorizing watery fluid. The staining of tubercle is, according to the author, due to a mantle of fat derived from the necrosed tissues or from the blood-serum; and if this be the cause the diagnostic value of the Ehrlich stain is lowered and ceases to be a characteristic of tubercle bacilli.

Staining Syphilis Bacilli.†—After the ordinary fixative in the flame and staining with fuchsin, Dr. De Giacomi washes the cover-glass with water in which a few drops of iron chloride are dissolved, and then decolorizes in concentrated iron chloride. The bacilli appear red; no other bacilli are stained. The preparation may be contrast-stained if desired.

Staining Micro-organisms in the tissues of children affected with hereditary Syphilis.‡—Drs. M. Kassowitz and C. Hochsinger have found, especially in the blood-vessels of the affected organs, collections of chain-cocci. The authors employed Gram's method. For permanent preparations it was found advisable either to leave the sections in the gentian-violet solution for 12 to 24 hours, or to use a concentrated solution (30 parts alcoholic gentian-violet solution to 70 parts anilin water). Acids completely decolorized the bacteria. Double staining was effected by means of picro-carmine, the solution being afterwards washed in a 1 per cent. hydrochloric acid alcohol, and then neutralized in a half per cent. solution of potash. By the foregoing method the bacteria appear dark blue, and the rest of the tissue a brightish red.

Staining of Lepra Bacilli.§—The well-known rapid disappearance of the stain from lepra bacilli induced Dr. P. G. Unna to ascertain the reason for this phenomenon, in order to be able to meet it by proper rules. The original supposition that the decoloration of the permanent preparations in question depends on an oxidation of the resins and ethereal oils used for clearing up and for mounting, was not confirmed: it rather turned out that if, as there is no doubt from Dr. Unna's experiments, an oxidizing action comes into play in the decolorizing of balsam preparations, this at any rate is to be regarded only as a reduction of the anilin colours. In order to trustworthily demonstrate the affinity for oxygen of the ordinary (i. e. in use) clarifying and mounting materials, Dr. Unna recommends the

* Fortschr. d. Med., iv. (1886) p. 193.
† Correspbl. d. Schweizer Aerzte, 1885, No. 12.
‡ Wiener Med. Blätter, 1886, Nos. 1–3.
§ Monatschr. f. Prakt. Dermatol., Ergänzungsh. 1885, p. 47. Cf. Zeitschr. f. Wiss. Mikr., ii. (1885) pp. 557–9.

following method, communicated to him by Dr. H. Hager. The fluid or its solution in absolute alcohol or benzol is treated with a few drops of mercury nitrate. If the body have any affinity for oxygen a grey metallic deposit is thrown down.

The results which Dr. Unna obtained with this test agree with the long known experience that oil of cloves and oil of turpentine are inimical to the anilin stains; for while, on the one hand, cedar oil as a clarifying agent and the hydrocarbons of the benzol-xylol series as solvents of the resins are superior to the former; yet on the other hand they show that the affinity for oxygen is detrimental to the anilin stains, for glycerin and carbolic acid, which, as is well known, quickly and permanently extract all basic anilin dyes, do not possess according to Hager's test, any reducing power. Together with the influence of oxygen there had been associated as a matter of course the acid nature of the resins which were charged with the decoloration of the preparations. Closer examination of the conditions showed that the acid reaction in itself did not so much represent the baneful factor, as rather the circumstance that the acids entered into new and unstainable combinations with the basic anilin dyes which were fixed in the tissues. In order to obviate as far as possible the latter contingency, the resins must be freed from all traces of ethereal oils by prolonged boiling and thickened to such a degree that they set immediately when applied to the preparation. But the deoxidation and the action of acids are not the only influences which make themselves felt; the remains of the acids (HNO_3HCl, acetic acid) used for the decoloration of sections are probably more dangerous than all the resin acids. Therefore for the removal of these residua the greatest care is required, for though we may avoid, as far as possible, all the mentioned sources of decoloration, there yet clings to the oil and balsam method the inconvenience of over-removal of the stain owing to the use of alcohol unavoidably necessary for dehydration.

Dr. Unna has now contrived a method which renders unnecessary not only the use of alcohol, but also the ethereal oils as clarifying media, preparatory to mounting in balsam—the so-called dry method. Here the stained sections, after decoloration by acid, and after staining with a second dye, are taken directly from water to be placed on the slide, and having next been carefully spread out and freed from superfluous water by pressing them with tissue paper, are heated slowly and carefully over a spirit-lamp to dryness. Upon the dried section and (if possible) warmed slide is poured a drop of the balsam selected. With regard to the permanence of the bacillar stain, the dry method, as far as can be gathered from Dr. Unna's comparative preparations, is not more efficacious than the oil method when carried out with the precautions insisted on by him. Yet the former, according to Dr. Unna's researches, which he reports in another treatise immediately following the one under discussion, and the contents of which cannot here be examined, should have, apart from their simplicity, the economy of material, time, and trouble, a noteworthy advantage for the recognition of micro-organisms and their relations to the tissues.

In a retrospect on the results thus obtained Dr. Unna gives detailed directions for carrying out both the dry and the oil methods, as modified according to the principles of the above-mentioned precautionary measures.

Solution of Hypochlorite of Soda with excess of chlorine as a Decolorizer.*—This solution is prepared by dissolving 8 parts of caustic

* Journ. de Micrographie, xi. (1887) pp. 154–5.

soda to 100 parts of distilled water, and passing chlorine through to saturation. The action is indicated by the following formula :—

$$2NaHO + 2Cl = H^2O + NaCl + NaClO.$$

The solution thus contains 7·45 per cent. of hypochlorite of soda. During the passage of the chlorine it is necessary to surround the solution with a mixture of salt and pounded ice, otherwise the temperature rises, and chloride and chlorate of soda are produced. The more effectual the cold, the greener is the colour of the fluid, but the greenness fades away by exposure to light and with lapse of time. The decolorizing action is proportional to the greenness of the solution, and is due to the presence of chlorine, and also to the hypochlorite of soda, which bodies act in virtue of their property of setting free nascent oxygen.

Experiments made with the foregoing solution by Prof. C. V. Ciaccio and Dr. G. Campari, on animal and vegetable tissues, have demonstrated its perfect efficacy, not only with the colouring matter of leaves and plants, but also with the pigment in the retina, in the chitinous investment of insects, and in melanotic morbid products. Hitherto these last three examples have been held to be unalterable. Specimens to be decolorized must first of all be hardened in alcohol and chromic acid or its salts.

LATHAM, V. A.—**The Microscope and how to use it.** X.
[Injecting—*contd.*]
Journ. of Microscopy, VI. (1887) pp. 102–11 (1 fig. and 1 pl.).

UNNA, P. G.—**Die Rosaniline und Pararosaniline. Eine bakteriologische Farbenstudie.** (Rosanilin and Pararosanilin. A bacteriological staining study.)
73 pp., 8vo, Hamburg, 1887.

(5) Mounting, including Slides, Preservative Fluids, &c.

Medium for clearing up Celloidin Sections.*—Dr. C. Weigert finds that a mixture of xylol and carbolic acid is efficacious for clearing celloidin sections stained with hæmatoxylin or carmine.

Three parts by volume of xylol are mixed with one part pure carbolic acid; and in order to be sure that water is absent from the mixture recently burnt, sulphate of copper is added. The copper sulphate is placed at the bottom of a 250 gram bottle, so as to form a layer about two cm. high. The mixture is passed over it, and the two are shaken up together. After standing, the clear fluid is decanted off.

This mixture is found to clear riband sections taken from 80 per cent. alcohol. It can only be used for carmine and logwood stained preparations, for basic anilin dyes are decolorized or removed from the sections by it. But for bacterial investigations, if the preparation be first stained with carmine, Gram's method, as used by Weigert, can be adopted, provided that anilin oil be substituted for the carbolic acid in the clarifying medium. The last method is, however, said to need improvement.

Reagents for clearing Celloidin Sections for Balsam Mounting.†—Dr. J. van Gieson finds that the only satisfactory reagent for clearing sections imbedded in celloidin is Ol. Origani Cretici, or Spanish hopfenœl. This clears rapidly, even in moist weather, after dehydration in 95 per cent. alcohol. It is free from acid, and does not fade the Weigert hæmatoxylin stain if the preparations have been hardened for a long time in Müller, and are mounted in thick balsam. It is also good for Gram's method, the

* Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 480–81.
† Amer. Mon. Micr. Journ., viii. (1887) pp. 49–51.

simple anilins, logwood, and eosin. When fresh it is of a light amber colour, and does not clear readily, but after having been exposed to the air it becomes darker, and its action more rapid.

The author finds that oil of thyme causes the Weigert hæmatoxylin stain to fade, and that its clarifying property is weak, requiring very thorough dehydration, and that it corrugates the celloidin. An unfavourable opinion is expressed as to the value of Minot and Dunham's clarifier, viz. the mixture of oil of thymol and oil of cloves. Anilin oil clears rapidly, and leaves the celloidin quite pliable, but unless thoroughly (almost an impossibility) removed, the preparation becomes yellowish-brown. Xylol requires very thorough dehydration, and corrugates the celloidin. Bergamot clears well, but damages the stain, especially eosin. Creosote is of very variable composition; some kinds dissolve celloidin. M. Flesch recommends beechwood creosote.

Mounting Sections prepared by Golgi's Method.* — Signor Magini, in order to render permanent preparations obtained by Golgi's method, recommends that the sections when taken from the bichloride of mercury, should be placed in a mixture of equal parts of absolute alcohol, and wetted and shaken up. They are then immersed in creosote for about half an hour, and when on the slide, the creosote is carefully removed with blotting-paper, and the preparations mounted in dammar dissolved in chloroform and ether.

Rapid Method of Dry Mounting.†—Mr. A. W. Stokes takes a mixture of equal parts of paraffin wax and bees'-wax; a piece the size of a pea is placed on a glass or metal slip. This is heated till it melts and forms a thin film; in contact with this are placed the rings intended to form the cells. First one side, then the other side of the rings is brought in contact with the melted wax. The rings are taken off, and in a second or two are cold and hard. One of these is placed on a clean glass slip in the position desired, and heat applied below the slip till the waxed surface of the ring melts and adheres. It is now allowed to cool. The object meanwhile is dried in a desiccator over sulphuric acid or calcic chloride; it is then placed in the cell and fastened in position by a minute fragment of wax. Gum will not do for fixing the object, since if really dry it will not adhere at all. A cover-glass is now taken, one side cleaned and heated; while still hot it is placed on the top of the cell. This top surface having already, as described, been covered with wax, the glass at once adheres, and the object is dry-mounted permanently. There is no liquid to sweat, and no time wasted in waiting for the cell to dry. So strongly does the mixture of waxes adhere, that it is not easy, without applying heat, to detach either cell or cover-glass. Cells can be made out of tissue paper, if required very shallow, or any of the ordinary rings may be used. Vulcanite cells, expanding and contracting very nearly the same as glass with differences of temperature, are preferable. Of course, the cells may be finished off afterwards with any of the usual cements.

The method does not require any turntable, brushes, or other of the usual apparatus; it is claimed to be inexpensive, rapid, effectual, and permanent.

Experiments with Media of High Refractive Index.‡—Mr. W. Morris has made a large number of experiments on mounting media of high refractive index, the object used being *Amphipleura pellucida*. The paper

* Boll. R. Acc. Med. Roma, xi. (1885) No. 7. † Eng. Mech., xliv. (1887) p. 148.
‡ Journ. and Proc. R. Soc. N. S. Wales, xix. (1886) pp. 121–33.

cannot be fully summarized here, and the original must be referred to by those desiring to know the results obtained with the various media.

Success was obtained with sulphur by special manipulation; also with piperine, the alkaloid of pepper, and with "biniodide of mercury, solid," which consists of a saturated solution of the biniodide in piperine. The alkaloids of opium, with few exceptions, are all high-class media; and of the alkaloids generally, the author says "for bacteria mounting, quick work, and splendid definition, giving immensity of light even to the F eye-piece, I am certain they cannot be surpassed, the bacteria being shown like beads of coral when stained with a red dye." Good results were also obtained by holding the prepared cover-glass over the mouth of a vial containing chloro-chromic acid, a highly volatile liquid giving off red fumes when exposed to the air.

Numerous chlorides and iodides were experimented with, of which we select the following:—

Chloride of tin is used thus:—"On placing a small portion on the mica slip and subjecting it to heat, dense fumes mixed with the water of crystallization are given off; and when only a clear liquid is left behind, still giving off white fumes. The cover-glass is held in position with a pair of forceps to intercept the fumes, a white deposit is immediately formed, and the moment a sufficient quantity is deposited, the cover-glass is withdrawn and held over the heated mica until resublimation takes place, leaving a metallic 'scud' on the cover-glass. When mounted in piperine, if properly managed, the diatoms will be found lying in a film of chloride of tin, the striæ beautifully defined, of a steel-grey lustre, and around the edge of the valve a golden-yellow tinge. The author thinks the definition quite up to the phosphorus mounts. Being a deliquescent salt, it must be mounted when hot, if not, moisture will be again absorbed, and the slide will be found to be worthless when mounted."

Iodide of arsenic gives splendid definition to the striæ, and is also of value for mounting bacteria.

Iodide and bromide of silver, with a little manipulation, will rival any of the phosphorus and silver mounts.

Of chloride of tellurium, the author writes, "This preparation, manipulated in the same way as the chloride of tin, is the best medium for showing the *A. pellucida* that I have experimented with. The richness of the colouring is something grand to look at. The beautiful steel-grey striæ, bold and well-defined, with the golden-yellow tinged edge of the valve, makes this the most showy slide that can possibly be exhibited, and in my opinion surpasses Professor Smith's American slide, the medium of which has a refractive index of 2·4."

Of chloride of thallium, he says, "This is a very fine medium; instead of the steel-grey a sea-green colour is given to the striæ; with the golden-yellow tinged edge to the valve, it makes a very pretty exhibit. It has a propensity of causing the piperine to crystallize; this can be got over by using the valerianate of quinine as a substitute for the piperine. I do not think this impairs the resolution, whilst it still keeps up the chromatic appearance. Some of the valves are resolved as well as with the tellurium, others again have got a varnished look, as if the interspaces between the striæ were filled up, and after careful examination minute cracks may be seen in the thin film covering the diatom, as if the thallium had infiltrated itself between the cover-glass and diatom. Those valves found in this state are not so well resolved, giving a more faint look to the striæ."

By mixing chloride of thallium and chloride of tin together, and sub-

liming as usual, the difficulty of crystallization with the piperine is got over, and also the varnished appearance to the diatom, giving a resolution better than any previous medium. The valves may be seen with the central rib jet-black, striæ a greenish steel-grey, hard and crisp, the outer edge either black or yellow tinged, according to the amount of film the diatom is lying in.

The author, who discards ringing, states that he is "prepared to mount, clean, label, and resolve the *A. pellucida* under five minutes' time, in one of the high refractive media, and in no part of the world can the same feat be performed at the present time, so far as our micro information is to hand to date" (November 1885).

New preparation of the medium of high index (2·4) and note on Liquidambar.*—Dr. H. L. Smith's yellow medium consists, as previously noted, of realgar dissolved in bromide of arsenic. It is not, however, the product known in commerce as realgar, that is a brownish-yellow opaque substance with a vitreous fracture, but the realgar of mineralogists, of a beautiful reddish-yellow colour and perfectly transparent. When Dr. Smith published the formula of his medium, the realgar was produced by melting two parts of sulphur with one part of metallic arsenic and keeping the fused mass at a red heat for several hours. After several attempts at making realgar, Dr. H. van Heurck found that it could be more easily and satisfactorily produced by melting together one part of sulphur and 1·7 part arsenious acid in a retort, and raising the temperature to distillation point. Realgar thus obtained by distillation quite resembles the mineral variety. It is then dissolved, by heat in a test-tube, in tribromate of arsenic, also obtained by distillation. The product is a syrupy liquid of a greenish-yellow colour, almost black in large quantity.

The diatoms being fixed to the cover-glass by desiccation, are covered with a drop of the liquid medium. The cover-glass is then placed on the slide, and the latter strongly heated in the flame of a spirit-lamp. Large bubbles are given off and the medium assumes a deep red hue, while at the same time the bromide of arsenic volatilizes. When the ebullition and the volatilization are nearly ended, the heating is ceased, slight pressure is applied to the slide, and it is then allowed to cool slowly. As it cools the medium loses its red colour and finally becomes of a pale yellow hue. During the manipulation, which is not difficult in itself, care must be taken to avoid the dangerous vapours.

Prepared in the manner indicated above, the medium has two disadvantages, first, the liquid alters very quickly, and can only be preserved in tubes hermetically sealed, secondly two-thirds of the preparations are spoilt, often very rapidly, and without any apparent cause. In order to remedy these defects, Dr. H. van Heurck made in the past two years numerous experiments, and at last found a method of preparing a solid substance which can be preserved without undergoing change in the air; and the preparations mounted therein have hitherto kept most perfectly. The author prepares his medium by dissolving in a glass vessel 30 parts by weight of flowers of sulphur in 10 parts of bromine, and thus obtains a solution of sulphur in the bromide of sulphur (S_2Br_2). After perfect combination, 13 parts of metallic arsenic in impalpable powder are added, and the mass heated until the arsenic is perfectly dissolved. The mass is then poured into a porcelain dish and heated over an open fire and constantly stirred with a glass rod until it is found that a small drop is very brittle when cool. The medium is then poured into a cold plate, and when

* Bull. Soc. Belg. de Micr., xiii. (1886-7) pp. 20–4.

quite cold the mass is divided into pieces and preserved in a stoppered bottle. This glassy mass, of a greenish-yellow colour, is what the author calls the first degree, and its index of refraction is = 2·1203 or 2·12 according to calculations made by the firm of M. Zeiss.

On heating for a longer time the mass thickens and the index = 2·2534 or 2·25. During the preparation of the object a part of the sulphur volatilizes and when properly heated the index may be 2·4. The two products may be used indifferently but both, especially the second, are difficult to melt. If so desired they may be dissolved at the time of using in a little bromide of arsenic, but then the same inconveniences may arise as from Smith's original medium.

Liquidambar prepared according to the author's formula is obtainable from M. P. Rousseau of Paris. Samples of the liquidambar show that the mass is hard enough to fix the cover-glass without the aid of cement. It is used either in its firm condition or previously dissolved in a mixture of alcohol and chloroform. Liquidambar, like storax, is unalterable with age; it allows structural details invisible in balsam to be clearly seen, and it may be used for histological objects as well as for diatoms. Bacteria mounted in storax or liquidambar show infinitely better than in Canada-balsam.

Fixing Sections.*—Mr. H. E. Summers writes that the method of fixing sections to the slide, as recently given by him,† has been found to be needlessly complicated when used for celloidin sections. The following simpler method is recommended.

Place the sections in 95 per cent. alcohol for a minute or two, arrange on the slide, and then pour over the sections sulphuric ether *vapour*, from a bottle partly full of liquid ether. The celloidin will immediately soften and become perfectly transparent. Place the slide in 80 per cent. alcohol, or even directly into 95 per cent. if desired. The sections will be found to be firmly fixed and may then be stained, cleared, &c.

Neat method for Rimming Microscopical Preparations.‡—Dr. A. Hansen, after alluding to the difficulty experienced in rimming round the cover-glass of preparations mounted in glycerin with the usual varnishes or lacs, states that the difficulty is easily overcome if the edge of the cover-glass be first run round with glycerin jelly which mixes easily with any superfluous glycerin. When cool the jelly allows a further coat of any varnish: the neatest is dammar.

BROWN, J. F.—**Mounting Opaque Objects.**

[3 × 1 in. strips of heavy cardboard with a central hole 3/8 in. in diameter. "The object to be mounted is placed over the hole of one strip, and then a second strip is placed over the first and secured to it, thus firmly holding the object between them."]

Amer. Mon. Micr. Journ., VIII. (1887) p. 73.

CODLING, W. E.—**Notes on Mounting. 1. Materials.**

Wesley Naturalist, 1887, pp. 81-2.

FRAZER, A.—**On a simple form of Self-centering Turntable for ringing Microscopic Specimens.**

[(1) Much larger and heavier than usual, so that slides which have the specimen mounted *not* in the middle of the slide will not project beyond the edge of the disc when being ringed; (2) the springs are made with a special form of "washer," so that these (the springs) may be turned freely in any direction; (3) the turntable is provided with a simple arrangement, consisting of three screws, which are placed in such positions upon the table that slides either

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* The Microscope, vii. (1887) p. 73. † See this Journal, 1886, p. 544.
‡ Zeitschr. f. Wiss. Mikr., iii. (1886) pp. 482-3.

of 1 in. or 1½ in., if placed against them, will be accurately centered; and the screws are also so arranged that when it is desired to use the turntable as a non-centering one, the screws may be depressed below the surface of the table.]
Trans. Edinburgh Naturalists' Field Club, I. (1885–6) pp. 333–4.

JAMES, F. L.—**Microscopical Technology.** [XV. Finishing the slide.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 36–41 (2 figs.).

(6) Miscellaneous.

Behrens's Tables for Microscopists.*—Dr. W. Behrens has here collected a series of very useful tables for microscopists and others. They comprise the comparison of the metric and English scales of lengths and weights as well as of thermometer scales; various tables of specific weights, refractive indices and dispersive powers; a numerical aperture table; and tables of hardening, fixing, imbedding, clearing, staining, and other media. There are fifty-four tables in all.

Method for Exhibiting Semi-Microscopical Objects.†—Herr F. Hilgendorf, after alluding to the difficulty of studying carefully small objects in museums, remarks that the exhibition of a large number of Microscopes is frustrated by the great expense and by the clumsiness of the public. The chief difficulty which arises from the differences of vision in different individuals, namely, constant alteration of focus, can be obviated by an ingenious contrivance such as has been employed by Dr. Zenker in the microscopical aquarium. This consists in every observer correcting his focus by means of a suitably chosen lens placed before the ocular, and with this lens traversing the whole series of Microscopes, each of which has been adjusted to the same focus.

The objects should be placed in a frame, the sides of which should be made of glass, and this frame, inclosing the specimens, set up in a vertical position close to a window. A hand-lens which allows a sufficient space between the glass and the eye for the nose and hand, would be necessary for examining purposes. The side plates of the frame must of course be made of smooth, clear, and not too thick glass. It will be found that at least 100 different semi-microscopical objects can be exhibited in each frame. As these frames stand only before the lower part of the window, darkening of the room need not be feared. If it be desirable to increase the number of preparations for examination, a contrivance adopted in some museums is recommended. This is an upright column around which are fixed a certain number of glass frames in such a manner that the latter can be made to revolve round the vertical axis.

The author enumerates certain objects suitable for such exhibition cases. These, beginning with the Protozoa, are chiefly Invertebrata, but many parts of vertebrates, such as fish-scales, otoliths, sclerotic rings, feathers, hairs, &c., are suggested.

Drying and Heating Apparatus for the Histological Laboratory.‡—Herr V. Meyer has had constructed an apparatus which, though intended for chemical work, may be found useful in the histological laboratory, instead of the incubator or hot chamber. In the latter the constancy of the temperature is maintained by means of the thermo-regulator. Meyer's apparatus dispenses with such adjuncts, because the temperature

* Behrens, W., 'Tabellen zum Gebrauch bei mikroskopischen Arbeiten.' (Tables for use in Microscopical Work.) 76 pp., 8vo, Braunschweig, 1887.

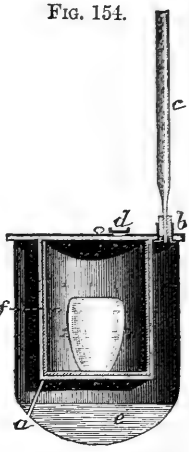
† SB. Gesell. Naturf. Freunde, 1885, pp. 13–6.

‡ Ber. Deutsch. Chem. Gesell., xviii. No. 17, p. 2999. Cf. Zeitschr. f. Wiss. Mikr., iii. (1886) p. 74 (1 fig.).

is kept constant by employing fluids of a definite boiling-point, as regards the required amount of heat, instead of a water-bath.

A double-walled vessel (fig. 154) contains the heating fluid *e* between the two walls, the object to be heated being within the inner chamber *f*. A tubular opening *b* in the top of the vessel carries a glass condensation-tube *c* for cooling the reflux air. Air-tubes *a* enter the dry chamber from below, and the cover has an opening *d*, which is closed by a slide. The apparatus is only intended by the inventor for high temperatures, but it will undoubtedly be easy to adapt it to the wants of microscopists for the use of fluids boiling at lower temperatures. The quantity of gas used is very small, a very small jet only being required to keep the fluid boiling.

FIG. 154.



'**Drying Apparatus for the Laboratory.***— Herr H. Rohrbeck has devised a drying apparatus which, by taking advantage of the circulating property of hot air, and by the adoption of a chamber for heating the air previously to its admission to the drying closet, is able to preserve an equable temperature in the internal chamber.

The apparatus, apparently, consists of a double walled case, five sides of which are protected by an asbestos layer. The internal chamber is surrounded by an interspace for the circulation of the exit air, while beneath its floor is situated a preliminary heating chamber subdivided into an upper and a lower compartment. The lower compartment is heated directly from beneath by a flame. From here the heated air ascends to the upper compartment, whence it finds its way through fenestrations to the dry chamber, out of which it passes to the interspace. Thus the dry closet is surrounded by warm air. The draught can be regulated by means of valves. The apparatus is closed by a double door and is provided with the usual thermometer and regulator.

Micro-chemical Analysis of Minerals.†—Dr. T. H. Behrens gives a description of methods used for the analysis of small fragments of minerals with the aid of the Microscope, based on the detection of the various constituents by conversion into various compounds, the crystallographic forms or appearance of which are well known.

The mineral is dissolved in hydrofluoric acid, or an acidified solution of ammonium fluoride, and the fluorides converted into sulphates under such conditions that the fluosilicates and fluoaluminates only remain unaltered. Then in the concentrated solution obtained the calcium is detected in the form of sulphate, the potassium as the platinochloride, sodium as a double sulphate of cerium and sodium, lithium as sulphate after separation of the calcium sulphate, and barium and strontium also as sulphates. The double phosphate serves to indicate the presence of magnesium, and an alcoholic solution of alizarin that of aluminium. For the detection of chlorine, mercurous is preferable to silver chloride; for fluorine the best reagent is sodium chloride, the fluoride being previously converted into a silicofluoride. Test analyses are given, which were made with 0·0002 gram of tourmaline, of an apophyllite, a boracite, and other minerals.

* Chem. Ztg., 1885, No. 21. Cf. Bot. Centralbl., xxvi. (1886) pp. 313–5.

† Rec. Trav. Chim., v. (1886) pp. 1–33. See Journ. Chem. Soc. Lond.—Abstr., (1886) p. 917.

Examining Fluid-cavities in Quartz.*—Dr. A. A. Julien, after describing the selection of the material and its preparation (by grinding thin sections or chipping off thin flakes), mounting and examination, points out that the chemical nature of the liquids and gases which occupy the fluid-cavities in quartz can be detected not only by chemical means, but by the use of a few simple microscopical accessories.

The expansion of the carbon dioxide by a slight increase of temperature above 20° C. is so great that advantage can be taken of its peculiar sensitiveness in this respect for its identification, on this minute scale, by very simple means. The simplest of all is a piece of rubber tubing, about 1 ft. long and 1/8 in. in bore. If the peculiar limpidness and delicate outline of the liquid in a fluid-cavity should lead the observer to suspect it to be liquid carbon dioxide, he has but to put this tube to his mouth, and blow a gentle stream of warm air for a minute or two upon the slide, from either above or below the stage. The simple warmth of his breath (about 32° C.) will be sufficient to convert the liquid carbon dioxide into a gas and thus to render its identification at once complete; for that temperature allows at least one degree to spare in reaching the point in the pure substance (31° C.) at which this change of state takes place. If there happens to be a gas-bubble of large size in relation to the layer of liquid in the cavity, the increase of temperature tends at the same time to expand the gas, and to cause the liquid to evaporate into the inner space. These two actions usually so counteract each other that hardly any change is visible. At other times, an appearance of boiling is produced. But when the temperature of 29° to 31° C. is reached, in an instant the liquid layer disappears, and nothing is visible within the cavity except the blurred outlines of its walls. The precise temperature at which liquid carbon dioxide thus passes entirely into the gaseous form within the cavity is termed its "critical point." This is a condition affecting all liquids, that is, all condensed gases; at a certain fixed temperature—which varies with the gas—the liquid flies into the gaseous state when heated in an inclosed cavity the walls of which are strong enough to resist the enormous pressure so resulting. When the slide has cooled back to the critical point (about 31° C.), the inclusion suddenly resumes the visible form it possessed before, or sometimes assumes the form of two or three bubbles, or even occasionally of a cluster or of a shower of bubbles. If the original gas-bubble happens to be much smaller in volume than that of the inclosing liquid, and the slide is warmed gently in the same way, the bubble will be seen to dilate steadily, often rapidly, with a similar sudden disappearance of the liquid layer near the critical point.

In all such experiments, however, the observer must be on his guard as to the temperature of the atmosphere, and of the mineral section at the beginning of the observation. In a warmly heated room, during the winter, and on a warm day, during the summer, the critical point may have been already passed and these transformations have become completed. In these circumstances, no indications of the presence of carbon dioxide will be visible at the first observation, unless care has been taken to keep the slide under examination cool, i. e. below 30° C., which may be done by previously dipping it in cold water. The temperature of the air at midsummer (30° to 33° C.) is often sufficient alone to bring the liquid up to its critical point under the eye of the observer.

In most mineral sections the fluid contents of the cavities consist of water or some saline solution which would usually remain but little

* Journ. N. York Micr. Soc., i. (1885) pp. 129–44.

affected in form or appearance during an experiment like that just described. Occasionally, however, the bubbles in a water-cavity are excited into lively motion and repelled into the farthest side of the cavity by the sudden application of heat. In place of a rubber tube, the application of a warm wire, glass rod, or of the burning end of a cigar, a little below the slide, may be substituted to produce the same effects—or even the direct application of the warm end of one's finger to the bottom of the slide for a few minutes.

The author gives an interesting description of the cavities and their contents, and the phenomena which they present.

Identification of Alkaloids and other Crystalline Bodies by the Microscope.*—Mr. A. P. Smith considers that whilst the number of cases in which a crystalline substance can be identified by the Microscope alone is extremely limited, yet, as a test of purity, microscopical investigation has a very wide application. When we are dealing with a substance that, when pure, crystallizes in a different form from any particular solvent, it is manifest that any departure from that form would lead to the suspicion of adulteration. If we take such a substance as bark, or opium, it is quite possible to distinguish from each other the various alkaloids which it contains. Besides the form assumed by the free base, it is of importance to convert it into a salt, as there is frequently a marked departure in the form of the crystals, e. g. quinidine and quinidine sulphate, cinchonidine and cinchonidine sulphate. There may be cases in which the salt and the base possess the same crystalline form.

Some experience is necessary in selecting the most suitable solvent from which to crystallize an alkaloid, as the duration of the evaporation may have a marked effect upon the form of the crystals. In some cases evaporation may be accelerated by the aid of heat; in others, such a proceeding is fatal to success. The addition of alcohol to ether, and of water to alcohol, appears to be the best means of retarding the process when necessary.

Polarized light should be employed to view the crystals, either with or without a selenite plate. Here, again, the duration of evaporation has a marked effect, also the strength of the solution. If the substance is deposited in a thin film, it may be altogether invisible without polarized light. Thick crystals frequently produce colour without the selenite, and those that are very thick may depolarize without any coloration. This being borne in mind, no difficulty is experienced in practice, as it is easy to compare with an alkaloid of known purity crystallized under the same conditions.

Figures are given of various substances crystallized under the best conditions, with the name of the solvent and the linear magnification, together also with a list of alkaloids and a description of the forms of the crystals.

CARPENÈ, A.—**Nuovo processo d' analisi delle materie coloranti, introdotte nei vini ed altri liquidi ed in sostanze alimentari solide, fondato sul coloramento dei micro-organismi.** (New process of analysing the colouring matters introduced into wine and other liquids and in solid alimentary substances, founded on the staining of the micro-organisms.) 11 pp. and 1 pl., 8vo, Torino, 1887.

COLE, A. C.—**Studies in Microscopical Science.** Vol. IV. Secs. I.–IV. Nos. 8–9 (each 4 pp.).

Sec. I. Botanical Histology. No. 8. Studies in Vegetable Physiology. VIII. Defoliation (Plate 8. A fallen leaf. Virginia Creeper: *Ampelopsis hederacea.* Long. sec. through the stem and base of petiole.) No. 9. Digestive Glands.

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* Journ. Postal Micr. Soc., v. (1886) pp. 210–8 (2 pls.), from 'The Analyst.'

(Plate 9. Vert. sec. of Leaf of Butterwort showing digestive hairs—slightly diagrammatic.)

Sec. II. Animal Histology. No. 8. Spermatozoa in the Invertebrata. (Plate 9. Spermatozoa of Invertebrata.) No. 9. Reproduction in Lamellibranch Mollusca. (Plate 9. Ovary of Mussel—*Mytilus*.)

Sec. III. Pathological Histology. No. 8. Acute Parenchymatous Nephritis (Acute Bright's Disease.) (Plate 8. Acute Interstitial Nephritis.) No. 9. Chronic Interstitial Nephritis. (Plate 9. Kidney in Leucocythæmia.)

Sec. IV. Popular Microscopical Studies. No. 8. Microbes (*contd.*). (Plate 8. Growing-points of stems.) No. 9. Roots, Stems, Growing-points and Leaves. (Plate 9. V.S. of Leaf of *Eucalyptus globulus* × 50.)

CROOKSHANK, E. M.—**Manual of Bacteriology.**
2nd ed., xxiv. and 439 pp., 137 figs. and 29 pls., 8vo, London, 1887.

Doherty's (A. J.) Histological Slides. *Amer. Mon. Micr. Journ.*, VIII. (1887) p. 52.

Harpe, E., de la.—See *Peyer, A.*

JAMES, F. L.—**Clinical Microscopical Technology.**
[I. Introductory. II., III. Examination of Urine.]
St. Louis Med. and Surg. Journ., LII. (1887) pp. 96–9 (1 fig.) 160–2, 231–3.

" " **Cleaning and drying Containers.**
[Directions for getting rid of minute quantities of water left in bottles after washing them, where the bottles are intended for holding oleaginous or balsamic mounting media or cements.]
St. Louis Med. and Surg. Journ., LII. (1887) p. 230.

LATTEUX, P.—**Manuel de Technique microscopique ou Guide pratique pour l'Étude et le Maniement du Microscope dans ses applications à l'Histologie humaine et comparée, à l'Anatomie végétale et à la Mineralogie. Introduction de M. le Professeur Trélat.** (Manual of microscopical technique, or practical guide to the study and management of the Microscope in its application to human and comparative histology, to vegetable anatomy, and to mineralogy.)
3rd ed., xvi. and 820 pp., 385 figs. and 1 phot., 8vo, Paris, 1887.

[MANTON, W. P., and others.]—**What practical use can the druggist make of the Microscope?** *The Microscope*, VII. (1887) pp. 55–6.
[By testing all crude drugs that come into his possession.]

" " " **Elementary Department.** First and Second Lessons. "Cleanliness is akin to godliness."
[Lessons based on actual laboratory work, placing "before the beginner, in the most elementary and primer-like manner, the details of microscopical technique."]
The Microscope, VI. (1886) pp. 76–80, 106–10 (2 figs.).

Naturalist's Laboratory. VII. Laboratory Furniture (*concld.*).
[Describes and figures a "Naturalist's Store Case" for Microscopes, dissecting tools, reagents, objects, &c., and so arranged that "the worker can construct his own cabinet piecemeal from time to time with but very little skill and at a very trivial expenditure." Also a "Book box for the storage of microscopical specimens."]
Knowledge, X. (1887) pp. 160–2 (2 figs.).

Peyer, A.—**Atlas de Microscopie Clinique.** (Atlas of Clinical Microscopy.)
Transl. by E. de la Harpe. 2nd ed., 100 pls., 4to, Paris, 1887.

Pharmaceutical Era, a monthly exponent of Pharmacology in all its departments, including Chemistry, Botany, Microscopy, and of the Art of Pharmacy. (A. B. Lyons, M.D., Editor.) Each No. 32 pp. Detroit, Mich., 1887.

QUEEN'S (J. W.) **Needle-holder.**
["It is a sort of universal chuck operated by a concentric screw-collar, and will hold needles of various sizes."]
Micr. Bulletin (*Queen's*), IV. (1887) p. 15 (1 fig.).

SESTINI, F.—**Sopra un nuovo metodo per discernere il burro artificiale.** (On a new method of distinguishing artificial butter.)
Atti Soc. Tosc. Sci. Nat.—Proc. Verb., V. (1887) pp. 218–23.

STOKES, A. C.—**Microscopy for Beginners, or Common Objects from the Ponds and Ditches.** 308 pp., 8vo, New York, 1887.

TRÉLAT, U.—See Latteux, P.

PROCEEDINGS OF THE SOCIETY.

Meeting of 13th April, 1887, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the Chair.

The Minutes of the meeting of 9th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Slides (13) of Diatomaceæ	*Mr. B. W. Thomas.*
Photomicrographs of *Floscularia*, *Melicerta*, and *Stephanoceros*	*Mr. J. B. Robinson.*
Photomicrographs of Snow Crystals	*Mr. A. W. Waters.*

Mr. B. W. Thomas's letter was read in reference to the thirteen slides of diatomaceæ, in which he suggested the necessity of having standard Maltwood finders.

Mr. Beck said there had been spurious imitations of Maltwood finders, so that it was impossible to guarantee the quality of all that were in existence. All the genuine ones, however, agreed with one another to within 1/1000 in. Mr. Maltwood originally asked them to carry out his plan, and they had a glass plate engraved, and all the finders they had sent out had been photographed from this. No doubt some enterprising American had endeavoured to make Maltwood's finders so as to offer them for a few pence less than the genuine ones. All the genuine Maltwood finders were made to the same standard, and there was no practical difficulty in insuring their correctness.

Photomicrographs of living rotifera (*Floscularia*, *Melicerta*, and *Stephanoceros*), by Mr. J. B. Robinson, were exhibited; also photomicrographs of snow crystals taken at Davos Dörfli, by Mr. A. W. Waters, showing some remarkable forms.

Mr. T. C. White exhibited a series of photomicrographs which he had recently taken, showing the results of the method of cutting off some of the superfluous light by means of a sliding diaphragm, so as to be able to admit just enough to bring out the detail and nothing more. The specimens shown were printed on Eastman's bromide paper, instead of silver paper, which he found brought out the character of the detail very much better.

The President was sure it would be interesting to all to note the improvements shown in these productions by Mr. White. The photomicrographs were certainly remarkably clear, and showed a distinct advance upon anything he had seen before.

Mr. F. R. Cheshire said that the small bottle which he held in his hand contained an object unmounted, which was very rarely seen, because ex-

tremely difficult to discover even by experts in the art of bee culture. It was generally well known that in the bee-hive all the eggs were usually laid by the queen, whose body contained about 300 various tubes, and who, under favourable conditions, was capable of laying even more than 3000 eggs in the course of twenty-four hours. After the accidental loss or intentional removal of the queen, the bees take some of the eggs remaining in the hive, and by a special feeding of the resulting larvæ are able to produce fresh queens. If, however, it should happen that in a hive which has lost its queen there are no eggs available for this purpose, it is found that some of the workers under some special circumstances, which could not be very clearly explained, became capable of laying eggs, but that such eggs produced drones only. These bees were known as fertile workers, and though there could be no doubt as to their frequent existence, they were very difficult to catch, owing to the fact of their being exactly the same in appearance as the ordinary workers. During the whole of his experience he had never but in three cases been able to secure specimens, and, besides these, only one or two isolated cases of verifying them had occurred in England. In the bottle to which he had referred were two of these fertile workers, having the ovaries drawn out of the bodies and attached to their stings and abdominal plates, so as to show that they really were workers. There was a remarkable peculiarity to be observed in connection with the ovarian tubes of these insects; every ordinary worker possessed an undeveloped ovary which it was very difficult both to detect and to dissect; but when under the influence of some stimulus the worker became fertile, a number of points began to appear in the tubes which afterwards became developed, and it would seem that the eggs were developed in alternation, an examination of the ovarian tubes showing them to contain developed eggs alternating with others in an undeveloped condition (as drawn on the black-board), and of which some very curious instances were seen in the specimens before the meeting. He hoped to be able to mount them, and if successful in doing so, he should have great pleasure in showing them at their next meeting.

Mr. Tebbs asked if there was any difference in appearance between the ordinary workers and those which Mr. Cheshire had just been describing?

Mr. Cheshire said that externally there was no distinguishable difference between them, though it was possible they might weigh a little more; dissection made the difference clear at once. They could only be detected when in the hive by the attentions which were paid to them by the other bees. A curious fact in connection with the queen was that although she had much smaller intestines than a worker, she was yet capable of producing nearly four times her own weight of eggs in the course of a day; and it would naturally seem very remarkable how so much nitrogenous matter could be produced by one whose organs of digestion and assimilation were so inferior in proportionate size, being actually less than those of a worker. But the fact was the queen did not herself digest her own food, but was fed upon a highly nutritive fluid from a gland in the head of the worker, in whose body the process of digestion had been carried on, and who conveyed the product to the queen by a special apparatus connected with the tongue. In the body of the fertile worker it was worth noting that no pollen was found such as formed the food of the ordinary bee, and this showed the fertile worker to be fed, like a queen, by the other bees.

Mr. Karop inquired how it was that Mr. Cheshire knew that the eggs developed alternately in the way he had stated, seeing that the opportunities for observation were so very rare?

Mr. Cheshire said it was only from what he found by examination of the ovarian tubes, and seeing that now and then there were gaps such as he had drawn, that he had ventured to give this as a suggestion. He rather intended the remark as a seeker after further information.

Prof. Bell asked if there was any reason to be assigned why one worker should be preferred to another in becoming fertile? Were there many such, or only a few in the hive which underwent this change?

Mr. Cheshire said it had been thought by some that these workers had been brought up in cells adjoining that of the queen, and might, therefore, have to some extent been nourished by some of the special food given to the larva of the queen; but since fertile workers had been found in hives which had never produced queens, this idea was hardly tenable. He thought it might be due to some special stimulus exerted by the bees under a strong desire to obtain eggs, though it was difficult to say of what nature the stimulus actually was.

Prof. Bell suggested that this bore some analogy to male lactation, as when a hare was shot some time ago in America suckling its young, and was afterwards found to be a male. The point of his inquiry, however, was how these workers became in the first instance induced to lay eggs—whether there were any stimulating circumstances which promoted their development? There appeared to be no doubt that attention was paid to them afterwards; but was there nothing which went before?

Mr. Cheshire said this was a question upon which he was seeking information. He was quite unable at present to answer it; but since all workers were at first fed in the larval state in the same manner as those intended for queens, and that the queens had this diet through all their larval development, it was highly probable that some of the worker larvæ were so fed for a longer period than others. Such would be especially favourable subjects for conversion into fertile workers.

The President said the point appeared to be whether the attention given to these workers was a cause or only an effect of the alteration in their condition.

Mr. Cheshire could only say that there was something about the queen which had some special fascination for the workers. They would come upon a knife which had been used to dissect a queen, or on the hand of a person who had taken up a queen. He had seen a rose-leaf upon which a queen had been placed visited in an inquiring manner by bees for many days afterwards, and the same thing occurred in the case of the fertile worker. Her body, although she had never copulated, attracted bees most singularly after she had been completely dissected.

Prof. Bell asked whether there could be any doubt as to the fact that these bees were really workers?

Mr. Cheshire said there could be none whatever; the queens were distinctly different in every part of their anatomy, so that there was no possibility of making a mistake.

Mr. Crisp called attention to the earliest known compound Microscope, one by Campani, of Rome, made at some time prior to 1665, as was evidenced by the absence of a field lens to the eye-piece.

Zeiss's new form of adjustable nose-piece was exhibited, in which the objective was made to slide on and off the nose-piece in an inclined plane, which insured its not touching the object when being changed.

Mr. P. H. Gosse's paper "On Twelve New Species of Rotifera" was read by Prof. Bell (*supra*, p. 361).

The President said that the Council had felt from time to time some responsibility as to the matters to be brought before the meetings, as well as objects of interest for exhibition, and their feeling was that it would be very desirable if there could be more talking and more exhibiting on the other side of the table. If some of the Fellows would (as Mr. Cheshire had done that evening) give some description of objects of interest or of recent observation, it would greatly add to the usefulness of their meetings.

Mr. Badcock said that, adopting the suggestion just made by the President, he might mention that he knew where to find something which at the present time was rather rare. In Victoria Park there was a pond where *Dendrosoma radians* and *Floscularia* could be found in enormous abundance, also *Brachionus* in several varieties; *Epistylis* in several species, with many other kinds of pond life, including Polyzoa, just now hatching out from the egg. The pond was one of the most extraordinary for the number of things which were to be found in it that he had ever known. If any Fellows of the Society interested in the matter would call upon him, he should be happy to point it out.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Melicerta conifera.*

Mr. F. R. Cheshire:—Fertile Worker Bees.

Mr. Crisp:—(1) Campani's Compound Microscope. (2) Zeiss's Adjustable Nose-piece.

Mr. J. B. Robinson:—Photographs of living Rotifera: *Floscularia*, *Melicerta*, and *Stephanoceros.*

Mr. B. W. Thomas:—Slides (13) of Diatomaceæ.

Mr. A. W. Waters:—Photographs of snow crystals.

Mr. T. C. White:—Various Photomicrographs illustrating his note.

New Fellows:—The following were elected *Ordinary* Fellows:—Col. C. K. Brooke and Messrs. E. Dadswell, D. De Vere Hunt, L.R.C.P., A. Mantle, M.D., and R. Pinkney.

MEETING OF 11TH MAY, 1887, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. DR. DALLINGER, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 13th April 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.

Bousfield, E. C., A Guide to the Science of Photo-micrography; containing Exposure-Table and rules for working. 69 pp. and Table. (8vo, London, 1887)	From *The Author.*

Crookshank, E. M., Photography of Bacteria. xix. and 64 pp., 22 pls. (8vo, London, 1887)	*The Author.*
Beale, L. S., The Mystery of Life. 71 pp. and 2 pls. (8vo, London, 1871)	"
—— Life Theories; their Influence upon Religious Thought. viii. and 97 pp., 6 pls. (8vo, London, 1871)	"
—— Bioplasm: an Introduction to the Study of Physiology and Medicine. xvi. and 345 pp., 22 pls. (8vo, London, 1872)	"
—— On Life and on Vital Action in Health and Disease. 110 pp. (8vo, London, 1875)	"
Sixty-two Slides of Entomological Subjects	*Mr. J. Deby.*

The President said that some time ago an alteration was made in the bye-laws, under which 100 Presidents of other Scientific Societies were eligible for election as ex-officio Fellows, and 78 Presidents were so elected. It seemed, however, that the Presidents of the Royal Society, the Linnean Society, the Royal Society of Edinburgh, and the Royal Irish Academy had not been included, probably because the eminence of these Societies would cause it to be assumed that their Presidents would be elected as a matter of course. The meeting now, no doubt, would be pleased to agree that the Presidents he had mentioned should be added to the list.

This was agreed to unanimously.

Mr. Crisp called attention, amongst the donations, to Dr. Crookshank's new work on the Photography of Bacteria; also to a number of slides of hair which Dr. Ondaatje, of Ceylon, had forwarded to the Society with a request for information as to its peculiarities of structure. If any Fellow would take the slides for examination and report to the next meeting, they would be glad to lend them for the purpose. Attention was also called to the intended re-delivery by the President on the 16th instant of the lecture which he gave with such success at the meeting of the British Association in Canada.

Mr. Deby presented 62 slides, chiefly of micro-hymenoptera, which came from the collection of the late Mr. Frederick Smith. There was also amongst them a complete series of slides illustrative of the development of the larva of a *Pediculus* from its first coming out of the egg to its mature condition.

Prof. Bell said that the late Mr. Frederick Smith was so careful an observer and collector as well as so skilful a mounter, that he felt sure that the present they had received was even of greater value than perhaps could be gathered from what Mr. Deby had said about it.

The President thought that the best thanks of the Society were due to Mr. Deby for his valuable donation, and a vote of thanks to him was unanimously carried.

Mr. J. Mayall, jun., said that he took it for granted the Fellows were interested in whatever concerned the history of the Microscope, and would therefore be glad to know of any new facts which tended to throw light upon the subject. They were told by some of the best authorities that the notes by Roger Bacon could hardly be considered as demonstrating that he had a practical knowledge of the use of magnifying lenses, and that his claim to be the inventor of them must be set aside. Fracastoro,

the eminent Italian physician, had referred to the magnifying power of lenses in a vague manner in his 'Homocentrica,' published in Venice in 1538; but this reference did not point to practical knowledge. Giovanni Baptista Porta had also been credited with the invention; but later writers, including Poggendorff, were doubtful if such was the fact. Libri was inclined to credit Galileo with the authorship—at least, of the combinations forming telescopes and Microscopes; but, on the other hand, it was certain that telescopes were known in Holland before Galileo's construction of these instruments. The evidence which he had come across lately conclusively showed that magnifying glasses were used at least as early as 1513–1520, for in the celebrated portrait of Leo X. by Raphael the Pope is shown holding one in his hand. This picture was painted between 1513 and 1520, as the Pope was elected in 1513, and Raphael died in 1520. He had brought to the meeting a volume which had been lent for the purpose by Mr. Quaritch, and which contained an engraving of Raphael's portrait of Leo X., so that the Fellows would be able to inspect it after the meeting.

During a recent visit to Florence he also paid some attention to the Microscopes which had been attributed to Galileo. It was, of course, rather difficult to say in such matters what was really authentic and what was not; but when these instruments were shown at the Loan Collection at South Kensington, there were suggestions made that they had been prepared for that exhibition, though he was assured by Prof. Meucci that they could be identified certainly since 1670, if not earlier. He could not, however, help noting that all the early telescopes made in 1660, or about that time, had cardboard tubes, and wood or horn cells for the lenses, whereas these Microscopes were made with substantial brass body-tubes with strong and well-made screw threads and firm tripod support. He could only say, therefore, that if the Microscope makers had arrived at that stage of perfection in Galileo's time, they had reached a point not attained by his successors until many years afterwards.

Mr. Mayall, in reply to an inquiry as to the supposed lens from Nineveh, said he could not add to what he had already stated in the Cantor Lectures, viz. that he did not find this so-called lens sufficiently clear to be used for magnifying purposes. It was made of rock crystal, and he thought that whoever intended to use it as a lens would have selected a piece without the veins across, which so marred it for that purpose, though, regarding it as an ornament, they rather added to its beauty. He thought Sir David Brewster had been rather hasty in coming to a conclusion about it. There had been also two pieces of glass found which had been taken for lenses, being plano-convex. One it was not possible to see through, the other was partly polished and might have been used as a burning-glass; but he had spoken to many authorities about them, amongst others to Mr. Madan, and they seemed of opinion that they were intended to be used as ornaments for the person, possibly for the helmet, or for the shoulder of the tunic.

Mr. J. Mayall, jun., also described a Microscope which had come from Japan. It was made after one of the old upright tripod models, and had a ring of inlaid silver ornamentation at both top and bottom, which was made with characteristic skill; but the person who had produced the instrument, though he had provided a place for the objective, had omitted to make any provision for the eye-piece.

Mr. Crisp remarked that though there was no place for lenses, yet there was an eye-piece guard to keep the dust out.

Mr. J. Beck said he had been examining the Microscope, and he could only say that he thought it a great libel upon the Japanese to attribute such a thing as that to them—a bogus Microscope. He could only suppose that it was the work of some amateur who got some Japanese rings of inlaid copper, and made the rest himself. Any one had only to look at the so-called fitting of the tube—which was no fit at all—to see the class of work, and for his part he did not believe it was Japanese work at all; there was English milling on the pillars. He had a large number of Japanese instruments, the workmanship of which was as fine as anything produced here.

Mr. Mayall said it would be folly to declare without actual knowledge that it was Japanese work, but it was quite certain that it was obtained from Tokio, and that it came direct here from Yokohama. Probably milling tools of English manufacture might have been used, as many other kinds of tools were used in Japan, and the ornamentation was undoubtedly Japanese work.

Mr. Deby said that many scientific instruments of English make were sent out to Japan, and he remembered seeing on one occasion 64 first-class Microscopes sent there by order of the agent of the Japanese Government. If, therefore, the people were well acquainted with Microscopes made by Mr. Beck and others here, it would be useless for any one there to produce such a one as that upon the table, as they would be quite certain that no one would purchase it.

Dr. Maddox's paper 'On the Different Tissues found in the Muscles of a Mummy' was read by Mr. Crisp, Dr. Maddox being unfortunately still unable to attend the meetings of the Society.

Prof. Bell said it was exceedingly interesting to find that a people who were so despised at the present time had succeeded in preserving the tissues of the body in this very remarkable way.

Prof. Bell gave an account of a recent visit which he had paid to M. Pasteur's laboratory in Paris.

The President felt sure that the Fellows were very much obliged to Prof. Bell for the very interesting account which he had given them, and for which their thanks were due.

Mr. Deby called attention to a series of double-stained sections of the rare parasitical plant *Brugmansia Löwii*, one of the Rafflesieæ, but differing in its being hermaphrodite. It grows on the overground roots of a species of *Cissus*, and was collected by him in 1884 in the Raritan range of mountains in Central West Sumatra. The sections show the development of the plant from the time it begins to raise the bark of its host as a minute tubercle up to the complete maturity of the ovules. The double-staining allows of distinguishing the limits between the tissues of the parasite and of its host, which on unstained sections cannot be determined.

The formation of the locula of the ovary is very remarkable, and partakes more of a fungoid growth than phanerogamic.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Cordylophora lacustris.*

Mr. Crisp:—Japanese Microscope.

Mr. Deby:—Series of sections of *Brugmansia Löwii.*

Dr. Maddox:—Photomicrographs in illustration of his paper.

Mr. J. Mayall, jun.:—Print of Raphael's Portrait of Leo X., with a hand magnifying lens, painted about 1513.

Mr. E. M. Nelson:—Diatoms in balsam shown with Lieberkühn.

Dr. Ondaatje:—Slides of hair.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. H. W. Carr, G. M. Dawson, D.Sc., F.G.S., Lucien Howe, M.R.C.S., and Miss V. A. Latham; and as

Ex-officio Fellows:—The Presidents of the Royal Society, the Linnean Society, the Royal Society of Edinburgh, and the Royal Irish Academy.

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-fourth of 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 post-free 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 9.30 P.M. also. It is closed for four weeks during August and September.

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.