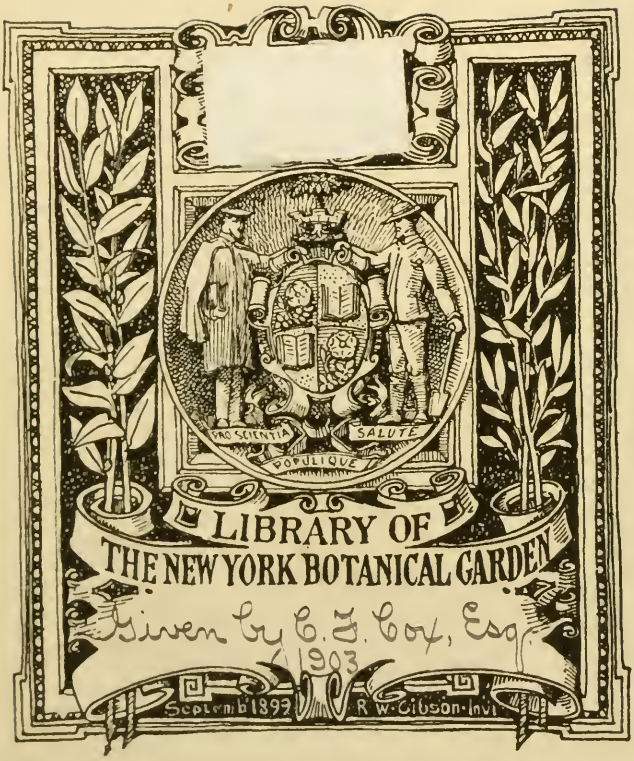
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JOURNAL

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.,

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., *Professor of Comparative Anatomy in King's College,*

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

FELLOWS OF THE SOCIETY.

Ser. II.—VOL. III. PART 1.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1883.

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 2*s*., payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of £2 2*s*. Future payments of the former may be compounded for at any time for £31 10*s*. Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

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

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

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

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

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows every week-day except Saturday from 10 A.M. to 5 P.M., and on Wednesdays from 7 to 10 P.M. also. It is closed on Saturdays and during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.

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CONTENTS.

ZOOLOGY.

A.—General, including Embryology and Histology of the Vertebrata.

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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.

Arthropoda.

a. Insecta.

β. Myriopoda.

γ. Arachnida.

δ. Crustacea.

Vermes.

Echinodermata.

Cœlenterata.

Porifera.

Protozoa.

BOTANY.

A.—General, including Embryology and Histology of the Phanerogamia.

B.—Cryptogamia.

Cryptogamia Vascularia.

Muscineæ.

Characeæ.

Fungi.

Lichenes.

Algæ.

MICROSCOPY.

a. Instruments, Accessories, &c.

β. Collecting, Mounting and Examining Objects, &c.

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

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Vol. III. Part 1.

FEBRUARY, 1883.

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(FEBRUARY, 1883.)

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

BOTANY.

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

MICROSCOPY.

ROYAL MICROSCOPICAL SOCIETY.

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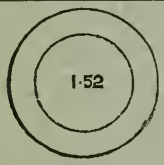
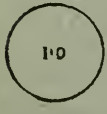
I. Numerical Aperture Table.

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

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

Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (¼ in.) from 0·50 to 1·52 N. A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$).			Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
		Dry Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)			
	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1 316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 167° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

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

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

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

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

ins.	μ
$\frac{1}{25000}$	1·015991
$\frac{1}{20000}$	1·269989
$\frac{1}{15000}$	1·693318
$\frac{1}{10000}$	2·539977
$\frac{1}{9000}$	2·822197
$\frac{1}{8000}$	3·174972
$\frac{1}{7000}$	3·628539
$\frac{1}{6000}$	4·233295
$\frac{1}{5000}$	5·079954
$\frac{1}{4000}$	6·349943
$\frac{1}{3000}$	8·466591
$\frac{1}{2000}$	12·699886
$\frac{1}{1000}$	25·399772
	mm.
$\frac{1}{900}$	·028222
$\frac{1}{800}$	·031750
$\frac{1}{700}$	·036285
$\frac{1}{600}$	·042333
$\frac{1}{500}$	·050800
$\frac{1}{450}$	·056444
$\frac{1}{400}$	·063499
$\frac{1}{350}$	·072571
$\frac{1}{300}$	·084666
$\frac{1}{250}$	·101599
$\frac{1}{200}$	·126999
$\frac{1}{150}$	·169332
$\frac{1}{100}$	·253998
$\frac{1}{50}$	·507995
$\frac{1}{25}$	1·015991
$\frac{1}{20}$	1·269989
$\frac{1}{16}$	1·587486
$\frac{1}{15}$	1·693318
$\frac{1}{12}$	2·116648
$\frac{1}{10}$	2·539977
$\frac{1}{8}$	3·174972
$\frac{1}{6}$	4·233295
$\frac{3}{16}$	4·762457
$\frac{1}{5}$	5·079954
$\frac{1}{4}$	6·349943
$\frac{5}{16}$	7·937429
$\frac{3}{8}$	9·524915
	cm.
$\frac{7}{16}$	1.111240
$\frac{1}{2}$	1·269989
$\frac{9}{16}$	1·428737
$\frac{5}{8}$	1·587486
$\frac{11}{16}$	1·746234
$\frac{3}{4}$	1·904983
$\frac{13}{16}$	2·063732
$\frac{7}{8}$	2·222480
$\frac{15}{16}$	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd. =	·914392

Conversion of British and Metric Measures—*continued.*

(2.) Capacity.

Millilitres, &c., into Cubic Inches, &c.

millilitres.		cub. ins.
1		·061025
2		·122051
3		·183076
4		·244102
5		·305127
6		·366152
7		·427178
8		·488203
9		·549228
10	(1 centil.)	·610254
20		1·220508
30		1·830762
40		2·441015
50		3·051269
60		3·661523
70		4.271777
80		4·882031
90		5·492285
100	(1 decil.)	6·102539
200		12·205077
300		18·307616
400		24·410155
500		30·512693
600		36·615232
700		42·717771
800		48·820309
900		54·922848
1000	(1 litre)	61·025387

= ·035315 cub. ft.

= 1·760724 pints.

= ·220091 galls.

Cubic Inches, &c., into Millilitres, &c.

cub. ins.	millilitres.
·1	1·638662
·2	3·277325
·3	4·915987
·4	6·554649
·5	8·193311
·6	9·831974
	centilitres.
·7	1·147064
·8	1·310930
·9	1·474796
1	1·638662
2	3·277325
3	4·915987
4	6·554649
5	8·193311
6	9·831974
	decilitres.
7	1·147064
8	1·310930
9	1·474796
10	1·638662
20	3·277325
30	4·915987
40	6·554649
50	8·193311
60	9·831974
	litres.
70	1·147064
80	1·310930
90	1·474796
100	1·638662

277·274 (1 gall.) = 4·543584 litres.

(3.) Weight.

Milligrammes, &c., into Grains, &c.

milligrammes.		grains.
1		·015432
2		·030865
3		·046297
4		·061729
5		·077162
6		·092594
7		·108026
8		·123459
9		·138891
10	(1 centigr.)	·154323
20		·308647
30		·462970
40		·617294
50		·771617
60		·925941
70		1·080264
80		1·234588
90		1·388911
100	(1 decigr.)	
decigrammes.		
1		1·543235
2		3·086470
3		4·629705
4		6·172939
5		7·716174
6		9·259409
7		10·802644
8		12·345879
9		13·889114
10	(1 gr.)	15·432349
		oz. avoir.
100	(1 decagr.)	·352739
1000	(1 hectogr.)	3·527394
		lbs. avoir.
10000	(1 kilogr.)	2·204620

Grains, &c., into Milligrammes, &c.

grains.		milligrammes.
·01		·647989
·02		1·295979
·03		1·943969
·04		2·591958
·05		3·239948
·06		3·887937
·07		4·535927
·08		5·183916
·09		5·831906
·1		6·479895
		centigrammes.
·2		1·295979
·3		1·943969
·4		2·391958
·5		3·239948
·6		3·887937
·7		4·535927
·8		5·183916
·9		5·831006
1		6·479895
		decigrammes.
2		1·295979
3		1·943969
4		2·591958
5		3·239948
6		3·887937
7		4·535927
8		5·183916
9		5·831906
10		6·479895
		grammes.
100		6·479895
	avolr.	decagrammes.
437·5	(1 oz.)	2·834954
		hectogrammes.
7000	(1 lb.)	4·535927

= ·453593 kilogrammes.

III. Corresponding Degrees in the Fahrenheit and Centigrade Scales.

Fahr.	Cent.	Cent.	Fahr.
500	260·0	100	212·0
450	232·22	98	208·4
400	204·44	96	204·8
350	176·67	94	201·2
300	148·89	92	197·6
250	121·11	90	194·0
212	100·0	88	190·4
210	98·89	86	186·8
205	96·11	84	183·2
200	93·33	82	179·6
195	90·56	80	176·0
190	87·78	78	172·4
185	85·0	76	168·8
180	82·22	74	165·2
175	79·44	72	161·6
170	76·67	70	158·0
165	73·89	68	154·4
160	71·11	66	150·8
155	68·33	64	147·2
150	65·56	62	143·6
145	62·78	60	140·0
140	60·0	58	136·4
135	57·22	56	132·8
130	54·44	54	129·2
125	51·67	52	125·6
120	48·89	50	122·0
115	46·11	48	118·4
110	43·33	46	114·8
105	40·56	44	111·2
100	37·78	42	107·6
95	35·0	40	104 0
90	32·22	38	100·4
85	29·44	36	96·8
80	26·67	34	93·2
75	23·89	32	89·6
70	21·11	30	86·0
65	18·33	28	82·4
60	15·56	26	78·8
55	12·78	24	75·2
50	10·0	22	71·6
45	7·22	20	68·0
40	4·44	18	64·4
35	1·67	16	60·8
32	0·0	14	57·2
30	− 1·11	12	53·6
25	− 3·89	10	50·0
20	− 6·67	8	46·4
15	− 9·44	6	42·8
10	− 12·22	4	39·2
5	− 15·0	2	35·6
0	− 17·78	0	32·0
− 5	− 20·56	− 2	28·4
− 10	− 23·33	− 4	24·8
− 15	− 26·11	− 6	21·2
− 20	− 28·89	− 8	17·6
− 25	− 31·67	− 10	14·0
− 30	− 34·44	− 12	10·4
− 35	− 37·22	− 14	6·8
− 40	− 40·0	− 16	3·2
− 45	− 42·78	− 18	− 0·4
− 50	− 45·56	− 20	− 4·0

IV. Refractive Indices, Dispersive Powers, and Polarizing Angles.

(1.) Refractive Indices.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air (at 0° C. 760 *mm.*)

(2.) Dispersive Powers.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air

(3.) Polarizing Angles.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp .gr. ·932)
Oil of turpentine (sp. gr. ·886)
Alcohol
Sea water
Pure water
Air

[Exact data for these tables are at present wanting.]

V. Table of Magnifying Powers.

OBJECTIVES. Focal Length.	Magnifying Power.	EYE-PIECES. Beck's 1, Powell's 1, Ross's A.	Beck's 2, Powell's 2, and Ross's B, nearly.*	Powell's 3.	Ross's C.	Beck's 3.	Beck's 4, Powell's 4, Ross's D.	Beck's 5, Ross's E.	Powell's 5.	Ross's F.
		Focal Length.								
		2 in.	$1\frac{1}{3}$ in.	1 in.	$\frac{4}{5}$ in.	$\frac{2}{3}$ in.	$\frac{1}{2}$ in.	$\frac{4}{10}$ in.	$\frac{1}{3}$ in.	$\frac{1}{4}$ in.
		Magnifying Power.								
		5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	20	25	30	40
		AMPLIFICATION OF OBJECTIVES AND EYE-PIECES COMBINED.								
ins. 5	2	10	15	20	25	30	40	50	60	80
4	$2\frac{1}{2}$	$12\frac{1}{2}$	$18\frac{3}{4}$	25	$31\frac{1}{4}$	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100
3	$3\frac{1}{3}$	$16\frac{2}{3}$	25	$33\frac{1}{3}$	$41\frac{2}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$
2	5	25	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100	125	150	200
$1\frac{1}{2}$	$6\frac{2}{3}$	$33\frac{1}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$
1	10	50	75	100	125	150	200	250	300	400
$\frac{8}{10}$	$12\frac{1}{2}$	$62\frac{1}{2}$	$93\frac{3}{4}$	125	$156\frac{1}{4}$	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500
$\frac{3}{4}$	$13\frac{1}{3}$	$66\frac{2}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$	$333\frac{1}{3}$	400	$533\frac{1}{3}$
$\frac{2}{3}$	15	75	$112\frac{1}{2}$	150	$187\frac{1}{2}$	225	300	375	450	600
$\frac{1}{2}$	20	100	150	200	250	300	400	500	600	800
$\frac{4}{10}$	25	125	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500	625	750	1000
$\frac{1}{3}$	30	150	225	300	375	450	600	750	900	1200
$\frac{3}{10}$	$33\frac{1}{3}$	$166\frac{2}{3}$	250	$333\frac{1}{3}$	$416\frac{2}{3}$	500	$666\frac{2}{3}$	$833\frac{1}{3}$	1000	$1333\frac{1}{3}$
$\frac{1}{4}$	40	200	300	400	500	600	800	1000	1200	1600
$\frac{1}{5}$	50	250	375	500	625	750	1000	1250	1500	2000
$\frac{1}{6}$	60	300	450	600	750	900	1200	1500	1800	2400
$\frac{1}{7}$	70	350	525	700	875	1050	1400	1750	2100	2800
$\frac{1}{8}$	80	400	600	800	1000	1200	1600	2000	2400	3200
$\frac{1}{9}$	90	450	675	900	1125	1350	1800	2250	2700	3600
$\frac{1}{10}$	100	500	750	1000	1250	1500	2000	2500	3000	4000
$\frac{1}{11}$	110	550	825	1100	1375	1650	2200	2750	3300	4400
$\frac{1}{12}$	120	600	900	1200	1500	1800	2400	3000	3600	4800
$\frac{1}{13}$	130	650	975	1300	1625	1950	2600	3250	3900	5200
$\frac{1}{14}$	140	700	1050	1400	1750	2100	2800	3500	4200	5600
$\frac{1}{15}$	150	750	1125	1500	1875	2250	3000	3750	4500	6000
$\frac{1}{16}$	160	800	1200	1600	2000	2400	3200	4000	4800	6400
$\frac{1}{17}$	170	850	1275	1700	2125	2550	3400	4250	5100	6800
$\frac{1}{18}$	180	900	1350	1800	2250	2700	3600	4500	5400	7200
$\frac{1}{19}$	190	950	1425	1900	2375	2850	3800	4750	5700	7600
$\frac{1}{20}$	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
$\frac{1}{25}$	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
$\frac{1}{30}$	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
$\frac{1}{40}$	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
$\frac{1}{50}$	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
$\frac{1}{60}$	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
$\frac{1}{80}$	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power, or respectively $\frac{1}{75}$ less and $\frac{1}{15}$ more than the figures given in this column.

Royal Microscopical Society.

MEETINGS FOR 1883,

AT 8 P.M.

1883.	Wednesday,	JANUARY	10
	„	FEBRUARY	14
		(Annual Meeting for Election of Officers and Council.)	
	„	MARCH	14
	„	APRIL	11
	„	MAY	9
	„	JUNE	13
	„	OCTOBER	10
	„	NOVEMBER	14
	„	DECEMBER	12

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

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

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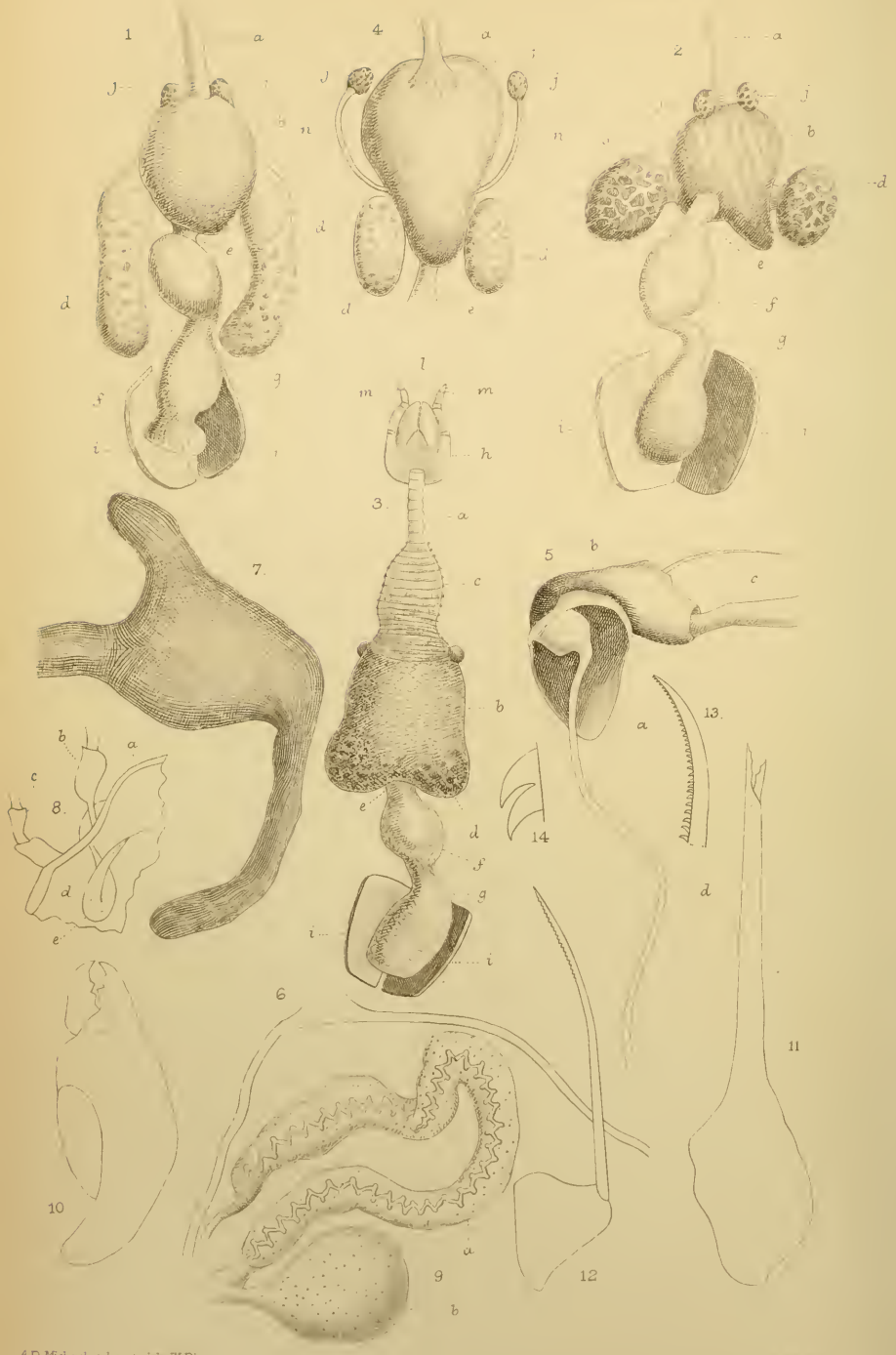

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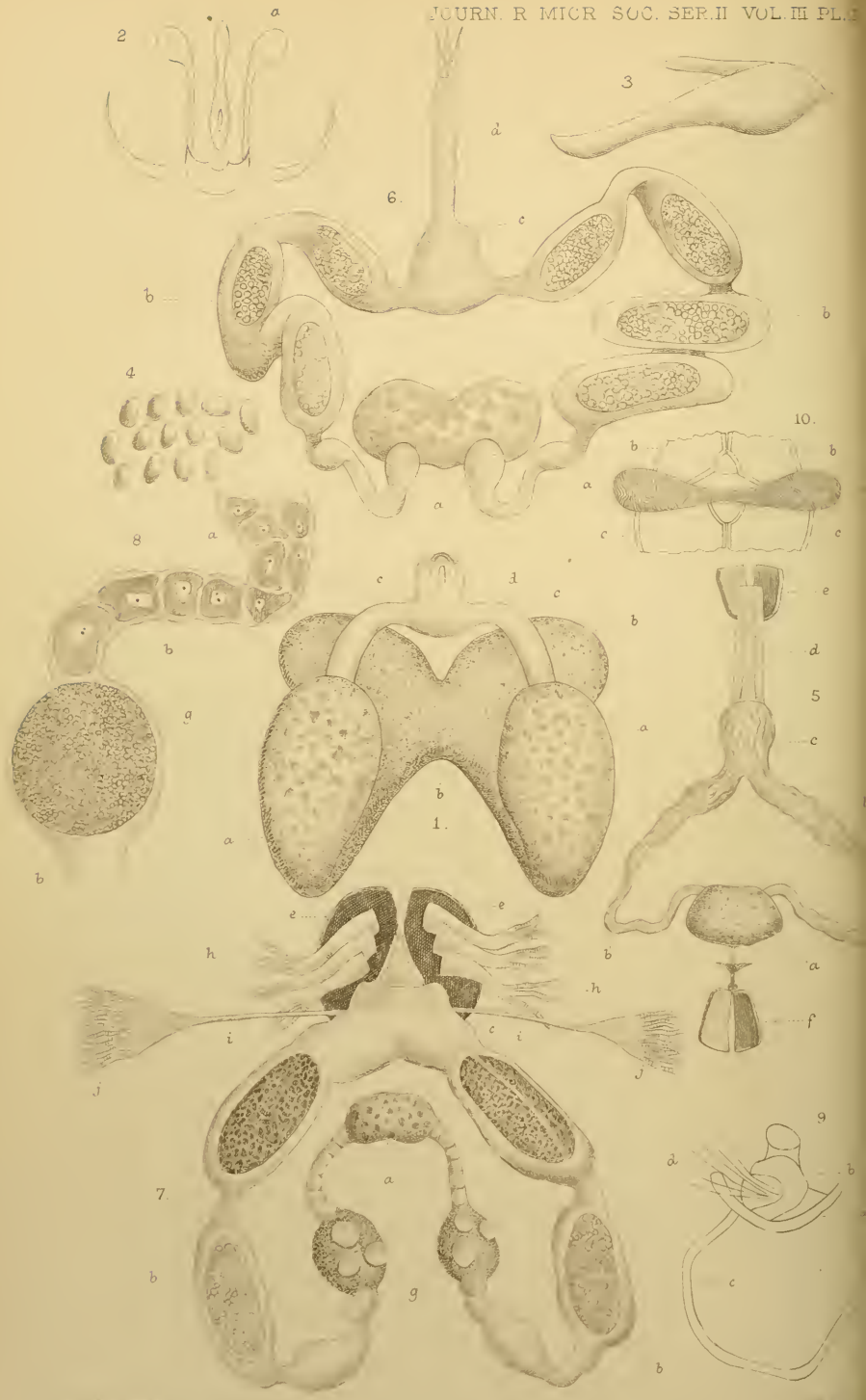
Anatomy of the Oribatidæ.



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Anatomy of the Cribatidæ.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1883.

TRANSACTIONS OF THE SOCIETY.

I.—*Observations on the Anatomy of the Oribatidæ.*

By A. D. Michael, F.L.S., F.R.M.S.

(*Read* 10*th January*, 1883.)

Plates I. and II.

In preparing the work upon the British *Oribatidæ*, which I am now writing for the Ray Society, it became desirable to deal, as far as I was able, with the leading features of the anatomy. It was

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1.—Alimentary canal of *Nothrus theleproctus*. × 50. *a*, œsophagus; *b*, ventriculus; *d d*, cæca; *e*, small intestine; *f*, colon; *g*, rectum; *i i*, anal plates; *j j*, preventricular glands.

„ 2.—Alimentary canal of *Hoplophora magna*. × 50. Same lettering.

„ 3.—Alimentary canal of *Damæus geniculatus*. × 35. Same lettering, and *c*, ingluvies; *h*, labium; *l*, maxillæ; *m*, palpi.

„ 4.—Part of the alimentary canal of *Leiosoma palmicinctum*. Same lettering, and *n n*, supposed ducts from preventricular glands.

„ 5.—Ending of trachea in the acetabulum of the third leg of *Damæus geniculatus*. × 100. *a*, acetabulum, removed from the ventral plate; *b*, coxa; *c*, femur; *d*, trachea, ending in a small air-sac in the acetabulum.

„ 6.—Two tracheæ of *Damæus geniculatus*, uniting into a single trunk before their attachment to the acetabulum of the second leg.

„ 7.—Air-sac near mouth of *Nothrus theleproctus*. × 350.

„ 8.—A portion of the left side of *Leiosoma palmicinctum*, the dorsal shield and all the internal organs, except the super-coxal gland, having been removed. *a*, wall of rostrum; *b*, first leg; *c*, second leg; *d*, ventral plate; *e*, super-coxal gland.

„ 9.—The super-coxal gland of *Leiosoma palmicinctum*. × 350. *a*, gland; *b*, globular body (vesicle?).

„ 10.—Mandible of *Oribata globula* (ordinary type in the family). × 180.

„ 11.—Mandible of *Pelops phœonotus*. × 600. Type of the genus *Pelops*.

„ 12.—Mandible of *Serrarius microcephalus*. × 250.

„ 13.—Serrated end of same mandible. × 500.

„ 14.—Two teeth of same mandible, highly magnified. [Plate II.

a subject upon which there were practically only three existing authorities. The first of these is Dujardin,* a keen-eyed observer, who saw a good deal, but unfortunately, as far as the *Oribatidæ* are concerned, drew conclusions from what he saw which have formed a stumbling-block for most later writers. The second is Nicolet,† and this may be treated as the only substantial work upon the subject. The third is Claparède,‡ whose work is excellent as far as it goes, but it only deals with one very exceptional species of this family, and that with a view to the development rather than the anatomy.

When I first commenced, my idea was simply to verify Nicolet's work before repeating his account in my own book; and to ascertain that it was correct, not only for the one or two species he had described, but also for others. As I advanced, however, I found so much variation in different forms, and so many points upon which I was not able to coincide with Nicolet's descriptions, that I was led to devote the greater part of my leisure during the summer and autumn of 1882 to the investigation: it has been

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PLATE II.

FIG. 1.—Male reproductive system of *Nothrus theleproctus*. × 50. *a*, *a*, lobes of the testis; *b b*, flat portion, possibly vesicula seminalis; *c c*, vasa deferentia; *d*, ductus ejaculatorius, with penis, penial skeleton, and sclerites, &c.

„ 2.—Penis and penial skeleton and sclerites of same species. × 600. *a*, penis.

„ 3.—Penis of same species, side view. × 1500.

„ 4.—Semen of *Damæus geniculatus*. × 1800.

„ 5.—Female reproductive system of *Oribata lapidaria*, taken when the creature has just emerged from the nymphal stage. × 40. *a*, ovary; *b b*, oviducts; *c*, vagina; *d*, ovipositor; *e*, genital plates; *f*, anal plates.

„ 6.—Female reproductive system of *Cepheus tegeocranus*, mature, showing the oviducts full of eggs. × 60. Same lettering.

„ 7.—Female reproductive system of *Damæus geniculatus*, mature, ovary nearly exhausted. × 50. Same lettering; and *g*, globular expansion of oviduct; *h h*, copulative suckers (so called); *i i*, tendons to genital plates; *j j*, muscles attached to same tendons.

„ 8.—Portion of the ovary and portion of oviduct of same species, up to and including the globular expansion. × 120. Same lettering.

„ 9.—End of trachea in acetabulum of leg of *Leiosoma palmicinctum*. × 180. *a*, edge of acetabulum; *b*, coxa; *c*, trachea; *d*, muscles of leg.

„ 10.—Anal sac of *Nothrus theleproctus*. × 100. *a a*, sac; *b b*, genital plates; *c c*, anal plates.

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* "Premier Mémoire sur les Acariens," Ann. des Sci. Nat., 3rd ser. iii. p. 5. Journal de l'Institut, 1842, p. 316.

† "Histoire Naturelle des Acariens, qui se trouvent aux Environs de Paris," Archives du Museum, vii. (1855). Paris.

‡ "Studien an Acariden," Zeitschr. f. Wiss. Zool., xviii. (1868) p. 446.

suggested to me that the results may be of interest to one of the biological societies, I have therefore described some of them in the present paper, instead of waiting to include them for the first time in the future treatise. I do not propose, in these pages, to give any exhaustive account even of such portions of the anatomy as I am acquainted with, that would be hardly fitted for this Journal, and would certainly be too lengthy, but I shall confine myself to such portions as seem to me to be undescribed, or to vary substantially from Nicolet's account, and to such other parts as are necessary to the comprehension of the novelties. It is only fair to Nicolet to point out, that, in his beautiful work above quoted, he states, that, in consequence of the minute size, and the hard, opaque, chitinous, exo-skeleton of these creatures, he found the internal anatomy extremely difficult. Claparède gives a similar reason for scarcely touching upon the internal anatomy.

There cannot be any doubt that Nicolet and Claparède were right as to the difficulty. The largest specimens are under a millimetre in extreme length, and many of the species which I have dissected are not above half that size; they are possessed of a chitinized cuticle which is nearly as hard and as brittle as glass, and which is usually quite opaque at all times except immediately after the ecdysis. I first tried observations at that period, but I soon found that I could not obtain much information this way, for, although, now that I am acquainted with the organs, I can frequently recognize many of them through the dorsal plate during its short period of transparency, yet the view is too imperfect, and the organs too much hidden by one another, for original inquiry. I endeavoured to stain them whole, but entirely failed in getting any stain to penetrate the chitin of the exo-skeleton, or even to run in at joints, stigmata, &c., although I tried the air-pump, hoping it might assist. Finally, after a not very satisfactory attempt at section cutting, I determined to face the difficulty of the small size, and to rely entirely upon actual dissection—these notes are the result.

I soon found, that, in order to produce a successful dissection, the creature must be in good, healthy, condition; it must not have been kept long in confinement, and it must be dissected immediately after death.

The dissections have, in each instance, been frequently repeated, i. e. upon a considerable number of specimens of each species, as, in consequence of the difficulties, the naturalist would be too liable to error in judging from one or two instances.

All the figures are made from actual dissections, they are not calculated, or put together, from the result of consecutive sections. The preparations from which the drawings are made, are, in almost all instances, now in my possession, stained with logwood, and

mounted for the Microscope, so that their appearance can easily be verified by any one interested in the subject, although of course different opinions may be entertained as to the correctness of the conclusions which I draw from them.

The dissections have chiefly been made under a Stephenson binocular, with powers varying from an inch to $\frac{1}{2}$ in. and low eye-pieces; they have, however, in cases requiring it, been verified and examined under amplifications running up to over 1000 diameters.

I think I may say that the tendency of my mind has been a desire to confirm previous writers, and not to upset their statements. Where I am not able to agree with them, it is that I have failed to obtain the same result, and that the actual organs before me do not seem to me to agree with the accounts.

The principal differences which I find in the internal organs are in the respiratory system, and the reproductive system. I find differences of lesser importance in the alimentary canal; and I believe that I have traced some secreting organs not before recorded; these are the points upon which I intend to touch; and, finally, I shall mention two matters in connection with the exo-skeleton which seem to me to be worthy of notice.

It is necessary to describe the alimentary canal in order that the varieties, &c., which it displays may be understood, although Nicolet figured the greater part of it correctly in one species.

The Alimentary Canal.

In the *Oribatidæ* the alimentary canal is somewhat short and simple, that is to say, there is a comparative absence of convolutions in the hind-gut, and the very numerous cæcal prolongations of the mid-gut found in many allied groups, as the *Aranea*, *Pienogonida*, &c., are reduced to two, which, however, are usually of great size and importance. The proportions of the parts of the canal, and the size and arrangement of the cæca, vary greatly in different species, but, as far as my experience goes, the divisions of which it is composed are always the same. I say "as far as my experience goes," because I have not dissected anything like the whole of the species.

The canal is composed of the œsophagus, the ventriculus, a short small intestine, the colon, and the rectum, terminating in the anus and anal plates; of these the two first are almost horizontal, and are placed in a straight median line near the dorsal surface; the small intestine turns downward and slightly forward, and the colon and rectum are more or less perpendicular, and lie beneath the ventriculus, or almost so; the result of this is, that, when the dorsal shield is removed, the œsophagus and the ventriculus, with its

cæca, are usually the only parts of the canal seen. The canal is, of course, firmly attached round the cavity of the mouth, and at the anus, but in other parts it seems to float freely in the general body-cavity, with only very slight attachments, if any. If the œsophagus be cut away from round the mouth, and the rectum from round the anus, a hair may easily be passed under the canal, and its whole length be drawn out on the hair without further injury.

Taking *Nothrus thelepractus* as a convenient type :—

The *œsophagus* is a long, thin, almost straight, tract of the canal, extending from the mouth to the ventriculus, and having its lowest point at the former and its highest at the latter. It has thin walls, capable, however, of considerable expansion and contraction. The cavity of the mouth being larger in diameter than the lumen of the œsophagus, the latter necessarily widens somewhat as it approaches the former, and the widened portion might, not unfairly, be termed the pharynx; posterior to this the œsophagus continues of almost even circumference for the greater part of its course through the cephalothorax; near its posterior extremity it widens, in some species this enlargement is considerable, and then forms an ingluvies or crop, the jabot of Nicolet; this writer correctly gives the ingluvies as very much developed in *Damæus geniculatus*, plate I. fig. 3, *c*; in *Damæus clavipes* it is even more developed and is almost as large as the ventriculus. I cannot say that I have ever seen it so large in other genera, but it is no doubt quite distinguishable in many others. Nicolet also, in the same drawing, depicts the œsophagus as being constricted at short intervals by circular bands of muscle, so that it presents a moniliform appearance. I have not been able to detect this moniliform effect in any other species which I have dissected, but the bands of muscle are usual. In the ingluvies of *Damæus geniculatus* these circular bands of muscle are beautifully seen after the preparation has been stained with logwood, and indicate that it is an expansion of the œsophagus, not a separate stomach. Nicolet further states that an air-bubble is invariably found floating in this ingluvies; my own observations do not quite confirm this; a large air-bubble is certainly to be seen very frequently floating in the canal, but it appears to me that it is not by any means invariably present, and that, when present, it is more frequently in the ventriculus than in the ingluvies; it is doubtless due to the creature's living chiefly upon liquid materials derived from vegetable substances, and absorbed by a sucking process, which accounts for the presence of liquid in considerable quantities in the fore- and mid-guts, and for those parts not being quite filled with it.

The œsophagus continues the whole length of the cephalothorax, and passes a very short distance into the abdomen; it is sharply

constricted by a circular muscular arrangement at the point where it enters the ventriculus, forming a very perfect valve, which prevents any food material from returning from the ventriculus to the œsophagus; this may often be seen very well by the air-bubble, which, carried by the liquid in which it is floating, may be observed to pass down from the œsophagus to the ventriculus, but it is always stopped at the valve whenever it has a tendency to return. The œsophagus enters the ventriculus about the centre of the anterior end, which possibly it may not be proper to call cardiac in a creature which is not known to possess any heart.

The *ventriculus* is the largest and most important portion of the canal; it is a wide sac, occupying from half to about two-thirds of the length of the abdomen, near the dorsal surface (plate I. figs. 1, 2, 3, 4, *b*). In *Nothrus theleproctus* the sac is of a shape approaching pyriform, the narrower end being the anterior one, this however is rounded, although smaller than the hinder part; the posterior end has a tendency to a blunt median point. The walls of this viscus are thick and muscular, more so than any other part of the canal except the rectum, and it is here that digestion doubtless chiefly takes place, a food mass may, most frequently, be seen occupying the pyloric portion. From the widest part of the ventriculus, i. e. about two-thirds of the length from the anterior end, a large cæcal diverticulum arises on each side, and, in the present species, after standing outward (laterally) so as to form a shoulder, proceeds almost straight backward. These diverticula are longer than the ventriculus itself, often more than half as long again, and nearly half its diameter; they are of almost even size throughout, so that they present a sausage-like appearance; their posterior ends are rounded.

There are probably greater differences between the ventriculus and cæcal appendages in different species and genera of the family than are found in any other part of the canal; this is especially true of the size and form of the cæca. In *Hoplophora magna* they have become very small in proportion to the ventriculus, which is widest anteriorly, and prolonged almost to a point behind. The cæca are globular, and are attached to the ventriculus by short peduncles (plate I. fig. 2, *d*). I mention this species, as Nicolet figures it without cæca, which is not correct in the specimens which I have dissected. In the case of *Damæus clavipes*, the cæca are not any longer distinctly visible, but are mere enlargements of the outer posterior angles of the ventriculus. *Damæus geniculatus* is an intermediate form in this respect.

Nicolet treats the cæca as being simply diverticula of the stomach, without any special office, and this probably may be the most obvious and natural suggestion; as far, however, as my own judgment goes, I doubt the correctness of the view. In the very

numerous instances which I have examined, to the best of my ability, I have not ever been able to detect food in the cæca, either in specimens dissected out or in those observed in life where the transparency of the chitin enabled me to do so, which was frequently the case; whereas it is rare to find the ventriculus or colon without food contents. In addition to this, the structure of the walls of the cæca, particularly near their distal ends, is different from that of the ventriculus, they being thicker and much more glandular, and the lumen smaller in proportion, often very narrow. These considerations lead me to infer that their function is secretory, and not simply that of an extension of the stomach, nor would there be anything extraordinary in this being so, as a very similar arrangement seems to exist in *Apus*, *Limnadia*, &c., the ends of the cæcal diverticula of the mid-gut being differentiated to form glandular organs, and the same arrangement, carried to a greater extent, prevails among the *Malacostraca*, &c. If these two large diverticula have, as I suppose, the office of secreting fluids necessary for digestion, it would explain to a great extent the apparent absence of the so-called hepatic tubes, an absence observed by Nicolet, who remarks that he was not able to detect any liver. In connection with this subject, however, must be taken the observations which will be found below as to the presence of diffused follicles, supposed by some writers to have a hepatic function, over the surface of the canal.

The *small intestine* (plate I. figs. 1, 2, 3, 4, *e*). This portion, forming the commencement of the hind-gut, may possibly be considered as simply a portion of the colon, from which it is not divided by any valve; but as, although short, it is always present, it may be convenient to treat of it under a separate heading.

The entrance to the small intestine from the ventriculus is always closed by a very efficient valve, which may occasionally be seen to open in order to give passage to the balls of digested or partially digested food. The small intestine proceeds from the ventriculus at a point lying to the left of the median line and near the pyloric end, but not actually at the end; the entrance is situated either at the edge of, or slightly on the under surface of the stomach, but its position varies a little in different species.

The *colon* (plate I. figs. 1, 2, 3, *f*), in all species in which I have examined it, is an elliptical enlargement of the hind-gut, very considerably smaller than the ventriculus, and usually clearly defined, particularly at the posterior extremity, where it is provided with a constriction or valve which usually completely closes the entrance to the rectum; it ordinarily turns downward, or slightly forward, so as to be brought more or less under the ventriculus. In a dorsal view when the notogastral shield has been removed without disturbing the position of the canal, only the anterior end

of the colon is seen. In my figures of the alimentary canal the colon and rectum are extended into a horizontal position so as to be seen.

Nicolet in his drawing of the alimentary canal of *Hoplophora magna* omits this portion of the canal altogether, but he gives one enlargement of the hind-gut almost as large as the ventriculus; this enlargement I presume he intends for the rectum. I can only say that I have not found such an arrangement in any of the specimens of this or any other species which I have dissected; indeed Nicolet's canal differs so materially from what I have met with, that I should think that we were dealing with different creatures, were it not that the species is an extremely well marked one. The walls of the colon are far less thick and less muscular than those of the ventriculus or rectum.

The *rectum* (plate I. figs. 1, 2, 3, *g*) is usually pyriform, sometimes very small where it arises from the colon, as in *Hoplophora magna*, sometimes larger, as in *Nothrus theleproctus*, but always distinctly divided from the colon by a sharp constriction; in some species, as *Oribata punctata*, it continues small for some little distance, gradually enlarging until near the anus, at, or within a short distance of which, it is closed by powerful sphincter muscles; the actual anal end of the rectum is attached round the opening on the ventral surface which is defended by the anal plates; a series of longitudinal muscles also arise from the posterior parts of the rectum, and are inserted in the exo-skeleton near the anal plates; they doubtless assist in supporting the rectum and holding it in its place, and probably also assist in defecation.

The rectum itself is muscular, with the bands of muscle arranged circularly; this is very clearly seen in *Nothrus theleproctus*, where, as in the last-named species, the constriction is some little distance from the anal plates; the portion of the canal between the two is comparatively very thin and delicate.

The Accessory Glands.—There are two conspicuous glands, not I believe mentioned by any author, which I propose to call the "preventricular glands"; they frequently show like two black spots through the dorsal surface, when at all transparent, particularly in the nymphs, but they are seen equally well in the adults when the chitin is not too opaque, and they appear to me to be always present. When dissected out they are found not really to be black but to vary in colour from deep yellow to dark brown. These glands are shown in plate I. figs. 1, 2, 3, 4, *j*, and are seated on the ventriculus at its extreme anterior part; one on each side of the œsophagus, just where it enters the ventriculus. The edge of each gland is on the dorsal surface of the ventriculus; so that, from the dorsal aspect, they look globular, and often are so, but more frequently they are somewhat flattened and show a tendency

to a bilobed form, in which case they extend down the side of the ventriculus as far as their size renders necessary; they are composed of large, loosely aggregated cells, and are easily broken up if disturbed in most species. Two similarly placed glands appear to exist in such Vermes as *Prorhynchus fluviatilis.*

It was some considerable time before I could trace the ducts from these glands at all to my own satisfaction, they are usually so very delicate that it is extremely difficult to detect them, and, although I thought that they followed the course which I now suppose to be correct, yet I could not feel any certainty. After trying numerous species I experimented on *Leiosoma palmicinctum,* in which I was pleased to find the ducts apparently more distinct; they seem, as far as I can at present judge, to run in an almost straight course along the surface of the ventriculus, which they appear to enter just above the cæca (this is shown in plate I. fig. 4, *n*), where they are delineated as separated from the ventriculus by dissection. If this course of the duct be correct, the office of these glands is doubtless the secretion of some fluid useful in digestion. The point cannot yet be considered as decided, as the glands have some attachment to the outer wall of the body. I have since found that they are equally well seen in *Notaspis lucorum.* Probably, if Burmeister's views were to be followed, these glands, from the place where their ducts seem to discharge, should be called pancreatic, but as the *Oribatidæ* are vegetable feeders the function would not be analogous. The glands and ducts possibly form the homologues of one pair of the anterior cæca of the ventriculus present in so many of the *Arachnida.*

The dorsal part of the anterior portion of the ventriculus and of the whole of the cæca is usually covered with a thickish layer of brown follicular-looking cells, which sometimes entirely cover the dorsal surface of the ventriculus. I cannot say that I have ever succeeded in detecting any ducts from this mass; they would doubtless be very fine, but I think that they are identical with those which many authors have considered as having a hepatic function. Thus Megnin, in his able treatises on the *Gamasinæ,** and on the *Sarcoptidæ* of mammals, says that he regards this brown granular substance as being analogous to that which coats the hepatic tubes of insects, and as being in fact the liver. A similar organization in many annelids was pointed out long since by Quatrefages,† who assigned it a similar office. Claparède speaks of the ventriculus, &c., and coating of cells as the "lebermagen" in the *Hydrachnidæ,* and that most careful anatomist, Cronberg,

* "Mémoire sur l'organisation et la distribution zoologique des acariens de la famille des Gamasides," Journ. Anat. et Phys. (Robin) 1876, p. 315. "Monographie de la tribu des Sarcoptides psorique," Revue et Mag. de Zool., 1877, p. 157.

† "Mémoire sur quelques Planariées marines," Ann. des Sci. Nat., 1845.

expressly states his complete adherence to Claparède's opinion, extending it to *Trombidium*.* On the other hand Leuckart † considered that a similar tissue in the leach was not hepatic, and Ledig in his histology agreed in this with Leuckart, and the more recent investigations of Professor E. Ray Lankester ‡ would seem to point rather to a blood-elaborating function for this "botryoidal" tissue.

I have not been able to find any salivary glands nor any appendages to the hind- gut.

The Reproductive System.

This, next to the alimentary canal, is the largest and most important set of organs in the body; the general arrangement is very similar in the two sexes. When the notogastral shield has been removed, the genitalia may be seen lying at the sides of the canal, and in some instances, in the female, when the oviducts are distended with eggs, they seem to have usurped the place of almost all the other organs, and to have pushed them out of position.

The Male Organs of Generation.—These consist of a large central testis, or more probably one on each side, coalescing in the median line by being imbedded in, and united by, a flat mass, which appears to perform the double office of increasing the quantity of the secretion and acting as a vesicula seminalis; two vasa deferentia, a ductus ejaculatorius, a penis with its accessory organs, and three pairs of copulative suckers.

The *testis*, treating the whole as one organ, is very large, sometimes appearing to half fill the body and force its lobes up to the notogaster; it usually extends the whole width of the body, and forms a saddle-shaped mass, which underlies the ventriculus in the centre, there constituting an almost flat layer of considerable thickness, deeply indented, both anteriorly and posteriorly, as though it were two paired organs which have met and united; no sign of suture or demarcation is however visible there (plate II. fig. 1, *a*, *b*). In addition to this, each side has a tendency to be bilobed, and the anterior lobe, which is part of the flat mass, in some species, or at some periods, rises much nearer to the dorsal surface than the posterior one; the whole varies somewhat in form in different species, in *Nothrus theleproctus* the anterior lobes are large and rounded, in *Oribata lapidaria* they are smaller and squarer. Along each side of the flat part already described, and partly imbedded in it, but not reaching its anterior edge, runs a raised, rounded portion, which is oval in *Nothrus theleproctus*, but varies a little in different species. I have not ever succeeded in

* "Ueber den Bau von *Trombidium*," Bull. Soc. des Nat. de Moscou, 1879.
† 'Die Menschlichen Parasiten,' vol. i.
‡ Quart. Journ. Micr. Sci., 1880, p. 317.

finding any demarcation on the inner side, where they join, nor in removing one from the other without tearing both to pieces. The substance of both is white, soft, and glandular, but the rounded lobes stain more deeply with logwood, and then exhibit a mottled appearance; these lobes are probably the true testes, the flatter central portion would seem to be more or less hollow, and to serve as a vesicula seminalis, as well, probably, as an organ secreting some fluid to increase the quantity of the spermatic material; at all events the walls are very thick and glandular.

The coalescing of the testes into an unpaired organ is of course common amongst the *Arachnida*, e. g. *Phalangium;* it also reminds one considerably of the arrangement in *Homarus*, and in *Pleuroma* and other free-living *Copepoda*, &c., among the *Crustacea*, and in insects a very close approach is to be found among the *Lepidoptera*, as in *Pontia brassicæ*, &c.; but if the flatter central portion acts also as a vesicula seminalis this would apparently be a departure from the crustacean type. Nicolet draws the testis in *Damæus geniculatus* as being four oval, free bodies, on each side, not imbedded in any flat central portion. I am not able to account for this; certainly, when they are seen through the dorsal surface in transparent specimens, or seen after the notogastral shield has merely been removed, they might be mistaken.

It may of course be suggested that the raised oval portion is the true testis, and that the central portion has some hepatic or other function, and not that of a *vesicula seminalis;* but the absence (as far as I have been able to ascertain) of any ducts except the vasa deferentia, and the fact that they lead out of the flat portion, and the intimate way in which the whole is fused into one mass, would seem to negative such a view.

The *vasa deferentia* are substantial tubes of moderate length, not longer as a rule than the testis itself; there is one on each side, springing from the anterior part of the flat portion, close to the raised oval (plate II. fig. 1, *c*), and passing downward, and slightly forward, until they join, and open into the ductus ejaculatorius; they have a great resemblance to the paired *vasa deferentia* proceeding from the unpaired testis in the above-quoted case of *Pontia brassicæ*. As a rule they are retracted towards the surface of the testis. There is but little variety in these organs in the species which I have dissected.

The ductus ejaculatorius.—The two vasa deferentia unite, as before stated, at their distal extremities, and are continued by an azygos duct considerably larger in diameter, but short; it is usually slightly invaginated, like the finger of a glove, and wrinkled longitudinally, so that it is capable of comparatively considerable extension and contraction. It is shown in plate II. fig. 1, *d*.

The penis and accessory organs.—Taking *Nothrus theleproctus* as an example, the penis is a small chitinous organ, broader near the distal than the proximal end, but almost pointed at each, the distal end being bulbous (plate II. fig. 3). Near this end there is a chitinous process to which the retractor and extensor muscles are attached. This penis, when retracted, rests in, and is protected by, a second chitinous piece (plate II. fig. 2), which is concave, like half a tube (cut longitudinally); the distal end, however, is closed by a semicircular return, or turning-up, of the half-tube, so as to form a shallow pocket, in the edge of which is a notch, evidently as a guide to the penis when protruded. The walls of the proximal portion of the half-tube are turned outward and expanded, so as to form pyriform blades, doubtless with the object of affording a firmer attachment.

The whole arrangement, when not in action, is retracted within a membranous sheath, which is retained in an open or distended condition by two curved chitinous pieces (plate II. fig. 2). The penis is, of course, in communication with the ductus ejaculatorius. This intromittent organ and its adjuncts bear a striking resemblance to those of *Carabus glabratus*, &c., in the *Coleoptera*: the drawing of the penis of one would almost serve for the other; the membranous tube is Burmeister's præputium, and the chitinous pieces are his horny ridges, or bones, distending the same. The whole of the male organs above described, particularly the testis, vasa deferentia, &c., have a marked similarity to those described by A. Cronberg for *Nesæa coccinea*.*

The copulative suckers, genital plates, &c., have already been well described by Nicolet.

As far as I have been able to observe, the spermatozoa are not mobile or flagellate. I have succeeded in obtaining them from *Damæus geniculatus* by breaking up the testis, and also by pressing the part which appeared to me to act as vesicula seminalis, almost immediately after death; they are small, elliptical, highly refractive, bodies, about the 1-10,000th of an inch in the long axis; they are figured in plate II. fig. 4, highly magnified. They closely resemble, except as to size, the semen of *Tegenaria guyonii* Guerin, one of the spiders which were shown to me by F. M. Campbell, of Hoddesdon; these were non-flagellate, although some spiders appear to have flagellate semen. Blane figures the semen of *Phalangium cornutum* and other species as non-flagellate.†

The Female Organs of Generation.—The general arrangement and position of these, as before stated, greatly resemble those of the male; it is, however, unnecessary to say that the differences are numerous and important. The organs consist of the ovary,

* 'On *Eylais extendens*,' Moscow, 1878 (in Russian).

† Bull. Soc. Vaud. de Sci. Nat., xvii. pl. 6, fig. 23.

the paired oviducts, terminating in an unpaired vagina, the ovipositor, and the copulative suckers and genital plates.

The ovary, or ovaries, for it is doubtful if they should be treated as paired or azygos, consist of a large central sac or gland, which underlies the ventriculus, in much the same position as that occupied by the testis; this I take to be the true ovary, from the walls of which the eggs are differentiated; it will be found fully developed, even when the creature has only lately emerged from the nymphal skin, and when there are not any eggs in the oviducts or other genital organs. At this period the walls of the ovary are cellular, the ova being more or less rudimentary (see plate II. fig. 5). At a later period, when the eggs have become developed, and when their formation and deposition is in active progress, the ovary may be seen to contain numerous eggs in a considerably more advanced state (plate II. figs. 6, 7). This central ovary appears to me possibly to consist of two paired organs, which have coalesced in the central line, much in the same manner as the testes. It is true that the ovary of *Oribata lapidaria* (plate II. fig. 5, *a*), *Oribata globula*, &c., is an elliptical organ, giving little, if any, indication of a dual origin, particularly when immature, but in *Cepheus tegeocranus* (plate II. fig. 6, *a*), in the mature ovary, there is a decided indication of a paired origin, there being a marked central constriction, and an approach to the outline of the coalesced testes. In *Nothrus theleproctus*, when the eggs are developed, the ovaries, or portions of an ovary, from the two sides have so slight an attachment to each other that they easily separate, and then appear as paired structures, one attached to each oviduct.

The oviducts.—These, like the vasa deferentia, are two paired ducts, arising, one from near each end of the central ovary; they are long, membranous tubes, which, before the eggs have commenced to mature, appear empty; they are then usually corrugated and plicated organs, of about even dimensions throughout; they are shown in this condition at plate II. fig. 5, *b*, but it must be understood that this and all the other figures of ovaries are drawn from preparations dissected out and partly extended; when *in situ* they are so much doubled backward and forward that a drawing of them in their actual position would not give much information. As the eggs are formed, and after they have increased a little in size in the ovary, they pass into the oviducts, where the principal growth takes place. The oviducts seem to perform the function of a uterus, and the passage of the egg through them is consequently very slow; the eggs will sometimes be found small in the portion of the oviduct between the ovary and the globular enlargement mentioned below, and large in that between those parts and the vagina; at all other times, or in other species, the eggs all appear about the same size, i. e. usually all fully grown. The oviducts with the

eggs mature are shown at plate II. figs. 6 and 7, *b*; their size then is quite disproportionate to that when the eggs are still in the ovary. The whole oviduct is greatly expanded, and each egg is lodged in a pocket, or chamber, formed by the distension of the elastic walls of the duct, and the flattening of the corrugations. This chamber usually follows the egg in its progress along the duct; in *Damæus geniculatus*, and probably in some other species, the earlier chambers do not appear to follow, or to subside after the passage of the egg, but persist to some extent; this may be due to the egg remaining an unusual time there while acquiring its chitinous shell.

In *Oribata globula*, *Damæus geniculatus*, and some other species, there is, on each side of the central ovary, and joined to it by a short portion of the oviduct, which is of equal length on each side, an almost globular extension of the oviduct, containing a globular body, which has the appearance of an ovum which has not yet assumed the oval form or the chitinous shell, and which almost entirely fills the chamber; these, like the central ovary, are developed when the creature first emerges from the nymphal skin, and while the other portions of the oviducts are unexpanded and empty. Both the central ovary, and certain large cells lying on or in the exterior walls of the two globular extensions, where the latter exist, stain deeply with logwood, &c., whereas the other portions of the oviduct scarcely take the stain at all. Whether these globular chambers be simply uterine, each containing an ovum, which here attains full size, or whether they are, or also function as, spermathecæ, or glands secreting a vitelline substance, or one destined to form the egg-shell, is a question which I have not been able to decide to my own satisfaction; some light may be thrown on the question of whether they function as spermathecæ when we know how copulation takes place, a matter which is not recorded, and which I have not succeeded in ascertaining; but it is certain that in *Damæus geniculatus*, the egg of which has a very hard chitinous shell, and other species having this globular enlargement, the eggs in the ovary, and between it and the globular body, are small, white, and soft, and show large clear nuclei and one or more round, distinct nucleoli, yelk-division not having more than commenced, even if it has commenced at all; but that, immediately they have passed this point, they have attained their full size, and the shell has become harder and darker, and yelk-division has largely progressed. This would seem to indicate that the globular body is an ovum and the enlargement a special point in the duct functioning as a uterus in these species. The only difficulty of this view would seem to be that the globular expansions, presenting similar appearance, are present in specimens just emerged, which have not any other eggs in the duct. A portion of the ovary with the part of one oviduct up to and including the globular chamber, is shown filled with eggs at plate II. fig. 8.

The duct, even when full of eggs, continues to be plicated longitudinally, so that the eggs, when *in situ*, often appear to lie at the side of the body, one over the other in a bunch; this however is a deceptive appearance, they really follow each other in single file along the duct. The ova sometimes lie end to end, sometimes obliquely across the duct, sometimes almost side by side (through the stretching of the duct); the position of the eggs in the duct is very irregular, I have not ever seen them all following one another end to end at regular distances, and regularly increasing in size from the first to the last, as figured by Nicolet, although the end to end arrangement is not unusual in the species he figures.

These oviducts are what Nicolet calls the ovaries, and what I term the ovipositor is named oviduct by him; I regret using the words in a different sense, but in the first instance it seems to me that his term is scarcely correct, although very natural, he not having observed the central ovary; and in the latter case, although the organ is unquestionably an oviduct, as far as the derivation of the word goes, yet it appears convenient to distinguish it by a name different from the duct between the ovary and the vagina.

The *vagina*, if this be a correct name for an organ which probably does not receive the male one, is a short but wide azygos duct, into which the oviducts lead; it is manifestly the homologue of the ductus ejaculatorius, and is of similar consistency to the oviducts of which it forms the continuation. It appears to vary but little in the different species which I have investigated; its office is to conduct the eggs from the oviducts to the commencement of the ovipositor. The egg does not remain in the vagina for any length of time.

The *ovipositor*, or external vagina of Burmeister, has been described by me in a former publication, and one form of it is well figured by Nicolet. I therefore shall not repeat it here; the same thing applies to the genital suckers and plates.

Nicolet figures the female reproductive organs of *Damæus geniculatus* more on the insect type than the crustacean, i. e. without the central ovary above named, treating my oviduct as the ovary, and drawing it as diminishing to a point at each side, with the eggs regularly increasing in size from the distal point to the vagina. I have not found any specimen in this condition.

It is necessary here to notice a remarkable error, as to the reproductive organs of *Oribatidæ*, for which Dujardin is responsible,* but which has somehow retained a place in modern English works of authority.† The usually keen-sighted French naturalist started with the initial error that the *Oribatidæ* were viviparous: he, having this idea in his mind, did not consider that they could

* "Premier mémoire sur les Acariens," Ann. des Sci. Nat., 3rd ser. iii. p. 5.

† Rymer Jones' 'Animal Kingdom,' 4th ed. p. 309.

have an ovipositor, and as he found the organ he took it to be the penis—a curious idea, for although that organ certainly attains a great length in some of the *Acarina*, e. g. *Proctophylodes* (*Dermaleichus*) *glandarinus* Koch, yet a male organ longer than the whole body, and thicker than the leg, would be an anomaly. Having settled this to his own satisfaction, Dujardin declared the opening below the hinder pair of plates to be the vulva, and concluded that the *Oribatidæ* were hermaphrodite; in this view Dujardin entirely forgot that the animals required an anus, and these errors still survive although Nicolet and Claparède have exposed them.

Respiratory Organs.

Nicolet* describes the respiratory system of the *Oribatidæ* as consisting of two conspicuous stigmata, one on each side of the posterior portion of the cephalothorax, each stigma being funnel-shaped, and opening, by a minute circular aperture, into an air-sac placed transversely in the body and bent upon itself in order to reach the stigma, and of four larger and two smaller tracheæ on each side, the longer ones being distributed two to the dorsal and two to the ventral surface, and forming many convolutions, and the two smaller being allotted to the cephalothorax; and he states that this arrangement is general to all the *Oribatidæ*, and only varies in other families of *Acarina*. I confess that until I began actually to dissect out the respiratory organs I never for an instant doubted the entire correctness of this description, and for a considerable time after my dissections had commenced, I thought that I must have missed the arrangement described by the French naturalist in consequence of the difficulty of the investigation. I found, however, that I could not, in any instance, trace the tracheæ up to the position described, nor could I find any air-sac in this place from which they originated, although I found a sac or tube, apparently glandular, not far off, but with liquid contents instead of air and not connected with the tracheæ. In the course of this investigation I have dissected over fifty specimens belonging to numerous species: I find, with sincere regret, that although many parts of Nicolet's descriptions are correct, yet I am not able to agree with him in other important particulars.

The breathing organs in the adults are usually, as he correctly says, tracheæ (I omit the air-sac question at present); these tracheæ are very long, and so delicate that the slightest attempt to move or separate them, even with the finest badger-hair, usually breaks them, and as they are, as Nicolet says, considerably convoluted, and are interlaced amongst the other organs, I have not found it possible to ascertain with certainty exactly how many there are.

* Loc. cit., p. 410.

I incline to think that it varies. I have also found that instead of being similar in all species the system differs materially.

To commence with the more ordinary arrangement, such as that found in *Oribata globula*, a very good species for seeing the tracheæ, *Damæus geniculatus*, &c. The main tracheæ are simple tubes, never anastomosing, and usually without any branches or dichotomous or other furcations or divisions; indeed I doubt if such ever exist. These tubes are much convoluted, or serpentined, and interlaced amongst the other organs. One large trachea on each side, which I will call the great dorsal, winds above the alimentary canal, very close to the notogaster, until near the posterior margin, when it takes a deeper course, following the alimentary canal, and becomes very difficult to trace. Another large trachea on each side, which I will call the great ventral, passes in a serpentine line along the ventral surface and is in connection with the sexual organs, winding about the oviduct and ovary in the female. Either one or two large tracheæ on each side proceed more along the lateral edges of the abdomen, between the two before described; there are also two or more shorter and finer unbranched tracheæ allotted to the cephalothorax on each side, one pair being distributed to the great muscles of the mandibles. The tracheæ are of almost even diameter throughout the principal part of their length, towards their ends they usually diminish and end in a point; this is not, however, invariable, as the large tracheæ, on the contrary, sometimes enlarge at their distal ends so as to form small bulbs.

The large tracheæ above described approach very near to each other at their origin, and if one does not actually follow them to their commencement (a matter of no slight difficulty), but is satisfied with their appearance after the removal of the notogaster, they unquestionably do look as if they were proceeding to the old so-called stigma (my pseudo-stigma) which seems to be the natural place for them to go to; if, however, the adipose tissue and muscle be removed, and the tracheæ followed to their origin, it will be found that they turn away from the pseudo-stigma, and end separately in the acetabula of the legs. The tracheæ are often enlarged at the commencement so as to form a small air-sac, which either wraps round or is attached to the inner side of the acetabulum: this is seen in plate I. fig. 5 and plate I. fig. 9.

One main trachea only usually proceeds from the acetabulum of each leg, but in some cases two proceed from that of the second leg, and more than one of the small cephalothoracic tracheæ from that of the first leg. In these cases they often join before reaching the stigma and form a very short joint trunk (plate I. fig. 6).

In consequence of the interlacing of the tracheæ among the organs it is far from easy to ascertain which trachea proceeds from each acetabulum, but it appears to me, as well as I could trace

them, that the great ventral trachea proceeds from the acetabulum of the fourth leg, the great dorsal from that of the third leg, the lateral trachea or tracheæ, which wind among the organs and cross right over the body, from the acetabulum of the second leg and the small cephalothoracic tracheæ from that of the first.

I think it possible that the two small tracheæ belonging to the cephalothoracic system find their stigmatic opening at the base of the maxillæ. I should be extremely doubtful about this last point were I speaking only of the species whose tracheæ are described above, as in them these tracheæ, wherever they open, are extremely fine and delicate; but in *Nothrus theleproctus*, &c., referred to below, the air-vessels in this situation are more powerful, and seem as though they were proceeding to the mouth, and it must be remembered that this is the position of the principal stigma, or stigmata, in *Cheyletus*,* *Trombidium*,† *Myobia*,‡ the *Hydrachnidæ*, &c.

In other members of the family, such as *Nothrus theleproctus*, the respiratory system above described is greatly modified: the origins of the tracheæ are placed in the same situations as in the species above described, but the nature of the air-vessels is very different; we no longer have long winding tracheæ of small diameter and very delicate walls, we have instead much shorter organs, thicker and less regular in form, and of a stouter and different texture, by which they may be easily recognized when the body is opened, as they have a thick, silvery appearance not easy to describe. Under a low amplification they assume that slightly iridescent appearance characteristic of a lined object under a power insufficient to resolve it; using a higher power regular cross lines are strongly developed, and a still greater amplification will show an object thickly and regularly covered with small circular bosses which will remind the observer of such a diatom as *Pleurosigma formosum*: this may, however, possibly be a deceptive appearance.

The tracheæ or air-vessels proceeding from the acetabula in the species now being described, are very much shorter and thicker than in the form before referred to, and are not convoluted or interlaced between the organs to the extent which we find in the longer and finer tracheæ of *Oribata*, &c.; at their extremity furthest from the stigma (the blind end) they are usually suddenly diminished in diameter and carried on for a very short distance in a blunt point.

In this form the air-vessels in the cephalothorax, which may

* Fumose et Robin, "Mémoire anatomique et zoologique sur les acariens des genres *Cheyletus*, &c.," Journ. Anat. et Phys. (Robin) 1867, p. 563.

† Pagenstecher, 'Beiträge zur Anatomie der Milben,' Leipzig, 1860, Heft 1, p. 19.

‡ Claparède, "Studien an Acariden," Zeitschr. f. Wiss. Zool., 1868, pl. 37.

possibly arise from oral stigmata, assume greater importance and become some of the largest; a short wide trunk leads into a chamber, from which proceed two cæcal prolongations of unequal length (plate I. fig. 7); these share with the other tracheæ the characteristic of being short, and of the structure described above.

It is very interesting to find this slightly developed and almost rudimentary condition of the tracheæ in the genus *Nothrus*, when we remember that the nymphs and larvæ all through the family usually have the tracheæ in a rudimentary state, and that in this genus the want of hard chitinization in the integument of the adults, their great resemblance to the nymphs, their carrying the cast skins in some species, and other indications, seem to point to creatures where the adult shows less progress from the nymphal stage than in other genera.

In the genus *Hoplophora* I have hitherto failed to discover any tracheæ whatever; Claparède was greatly surprised at the same thing,* he found, beneath Nicolet's stigma, which he calls *peritrema*, three very minute sacs filled with air, which he says are not longer than the width of the stigma, and which, from his drawing, cannot be above the 1-250th of a millimetre in length (his entire creature being over a millimetre); he considers these to be the entire respiratory arrangement of the creature, and to be modified tracheæ, equivalent to the so-called lungs of spiders, scorpions, &c. Although he did not find any leaf-like arrangement within the sacs, or any blood-vascular vessels in connection with them, it must, however, be remembered that Claparède was doubtless relying upon the statement of Nicolet, whose book he quotes, that the tracheæ in other species arose from this so-called stigma.

Claparède expresses his astonishment at the extremely rudimentary condition of these respiratory organs, and he well might do so; one naturally is diffident of questioning a conclusion on this subject arrived at by a man so extremely well acquainted with spiders' lungs as Claparède, but I cannot think that a sufficient respiratory system is shown here; it seems to me far more likely that these minute sacs are connected with the functions of hearing or smell performed by these pseudo-stigmata as suggested by me in an earlier number of this Journal, and it seems to me that there are other means to be found by which aeration could take place in *Hoplophora*. We know that in many soft-skinned acari, as *Tyroglyphus*, *Sarcoptes*, *Dermaleichus*, &c., respiration is performed by the general body-surface without special organs; now in *Hoplophora*, in consequence of the movable ventral plate, so different to that of other *Oribatidæ*, its opening and closing must have a bellows-like action, and great quantities of air must be drawn inside the carapace

* "Studien an Acariden," Zeitschr. f. Wiss. Zool., 1868, p. 512.

and over the delicate lining membranes through which aeration of the blood may well take place.

Before leaving the subject of the respiratory organs I will say a word more as to my not adopting the view held by Nicolet and Claparède, and generally received, that the two organs which look like stigmata on the cephalothorax really are so. One hesitates greatly to attack a conclusion supported by so much authority, but Nicolet is really the only observer who has ever investigated beyond the external appearance; Claparède only dissected *Hoplophora*, and there he did not find anything in connection with the so-called stigmata except the minute air-sacs referred to above. The matter is one of fact; of the tracheæ large enough to be traced I have not ever succeeded in finding one attached to the so-called stigma, or proceeding from any air-sac attached to it, and I have found them originating in other places, as detailed above. Again, the pseudo-stigmata are quite as highly developed in the larvæ and nymphs as in the adults, although the tracheal system is quite rudimentary in the immature forms as far as the observations of other arachnologists and of myself extend, a circumstance (as to the absence of tracheæ in immature forms) also observed by Pagenstecher in *Ixodes* and *Trombidium*, and by Kramer in *Gamasus*, *Tarsonemus*, &c.; and again the extremely small internal opening of the pseudo-stigmata, which is almost or quite filled by the peduncle of the so-called protecting hair (my pseudo-stigmatic organ), is against the hypothesis of their being true stigmata. For what it is worth, it may also be mentioned that in *Pygmephorus spinosus*, a parasite of the mole, which possesses organs much resembling the pseudo-stigmata of the *Oribatidæ*, Dr. Kramer, its discoverer, could not trace any tracheæ to these organs; * although doubtless the weight of this is lessened by the fact that, in consequence of want of specimens for investigation, he was not able to trace the tracheæ to any stigma.

The Super-coxal Glands.

I have said above that Nicolet describes an air-sac which I cannot find, but that I do find a sac, which I believe to be glandular, not far from Nicolet's position, although not attached at the point he names. This sac I propose to call the super-coxal gland, and I have very little doubt, from Nicolet's drawing, that this is the organ he saw and supposed to be connected with what he and others imagined to be the stigma. When the dorsal exo-skeleton of the cephalothorax, and the adipose tissue which underlies it, has been removed, what appears to be the enlarged, blind end of a fine

* "Zwei Parasitische Milben des Maulwurfs," Archiv f. Naturgesch., 43rd year, Bd. 1, p. 257.

colourless sac, may be seen on each side of the body, the seemingly blind end being nearest to the eye; the sac descending obliquely downward and slightly forward, and being attached close to the acetabulum of the coxa of the second leg; a closer examination shows that this is not the only attachment, but that the lower end is apparently bifurcated, and that the second branch is attached much nearer to the centre of the body, and higher in level than the coxal branch. On dissecting out this sac, and carefully extending it, a matter by no means easy, it will be found that what seemed to be the blind end was not the end at all, but that the whole organ is an elongated, sausage-shaped sac, bent upon itself in the middle and taking a single turn, so that the two halves cross, but for some distance the two limbs of the horseshoe (if I may call them so) lie over each other, or are so closely pressed against one another as to appear one; it is only toward the ends that they stand free from each other when *in situ*. The general position of the organ in the body is shown at plate I. fig. 8; and the organ unfolded and showing so much of its minuter structure as I am acquainted with at plate I. fig. 9. The walls of the sac are colourless but highly granular, and apparently of considerable thickness, and, it appears to me, decidedly glandular. Within the sac, i. e. either on its inside surface or in the substance of the wall, and near to the centre (long axis) of the sac, is a double row of highly refractive points, arranged at regular distances, those of the two rows not being opposite, but alternate. A fine distinct double line may be seen uniting these alternate points so as to form a double zigzag line all along the organ, the refracting points being slight prolongations of the zigzags. Three possible explanations of this structure would seem to offer themselves. 1. That the double lines are tubules as in the nephridia of Vermes. 2. That the space between the fine lines is really the zigzag lumen of the sac, possibly running between cells projecting alternately from the opposite walls, and having a cuticularization at the refractive points. 3. That the whole (zigzag and points) is a cuticular strengthening on the interior wall of the sac, the cuticularization being greatest at the refractive points which may be intercellular.

Connected with this tube is a globular body, which has thick but less granular walls, and which is probably hollow; both the gland and this body, when pressed, discharge liquid. There is not any sign of air in either.

What is the office of this organ? I cannot, of course, pretend to do much more than guess, but if a suggestion be allowable, I would point to the nephridia (segmental organs) in Vermes, and the green gland in *Astacus* and other crustacea, and the coxal glands in *Scorpio* and *Limulus*, as those where the analogy may be sought. The resemblance to the former, in particular, is very

considerable in the general form of the organ, and to a lesser extent in the minuter structure; if the double lines be tubules they would be analogous to those in the nephridia.* The sac above described (super-coxal gland) would correspond with the gland in the nephridium, and the globular body with the vesicle.

The position would seem to correspond fairly with that of the green gland and the coxal glands, in the former of which Will and Gorup-Besanez say that they found guanin,† and Huxley says that if this be so there can be little doubt that it represents the kidney, and its secretions the urinary fluid;‡ while Ray Lankester is inclined to look on the latter as homologous with the nephridia.§

I cannot say that I have succeeded in finding any actual opening of the super-coxal gland to the exterior, but the extremely small size of the creatures and of the gland, and the position of the latter, make it very difficult, and indeed Professor Lankester does not seem as yet to have been more successful in this particular respect with the larger forms which he has been dealing with.

In *Hoplophora magna*, about in a similar place to the above-named super-coxal glands (as far as the peculiar form of *Hoplophora* will allow), I find, on each side of the body, a pyriform sac, having the smaller end toward the legs, and the larger, blind end, toward the centre of the body; this sac has walls less finely granular than the glands in *Leiosoma*, &c., but very glandular; I have not found in it either the refractive points or the zigzag markings; it is not bent nor doubled on itself nor twisted; there is a globular vesicle, darker in colour than the sac, on each side of it. These organs require further investigation, but it would appear probable that they are the homologues of the super-coxal gland and vesicle, although presenting considerable differences.

The Exo-skeleton.

The only two points relative to the exo-skeleton which I intend to refer to are:—1. The tectum; 2. The mandible of the species which Nicolet calls *Leiosoma microcephala.*

The *tectum* is a part which owes its name to Nicolet; he alone has pointed out the existence of such an organ; as far as I know it does not exist in any other creatures, and it will be seen from the following remarks, that, in my opinion, it does not exist at all.

Nicolet's statement, when treating of the cephalothorax, is as follows:—"In a large number of individuals, forming the first division of the *Oribatidæ*, the upper part of the cephalothorax is

* See A. G. Bourne, "On the structure of the Nephridia of the Medicinal Leech," Quart. Journ. Micr. Sci., 1880, pp. 283–302.

† Gelehrte Anzeigen d. K. Baierischen Akad., No. 233, 1848.

‡ 'The Crayfish,' 1880, p. 83.

§ Proc. Roy. Soc., xxxiv. (1882) pp. 95–101.

dominated, and sometimes entirely hidden, by a lamellar and tectiform expansion of its base, which advances forward, following its declivity (that of the rostrum), and assuming a form more or less triangular, according as the former is more or less angular, the sides of which expansion are raised oblique projections, often prolonged beyond the front (of the expansion), and always terminated by two setiform hairs. This apparatus, of the functions of which I am ignorant, but which I consider as a protecting organ, and to which I have given the name of tectum, extends from the base of one stigma to that of the others. The lower face of this organ, where it is opposed to the upper surface of the cephalothorax, is not always free in all species; there even exist some in which it is adherent all its length, and then the tectum is only distinguished by its lateral wings, which in that case are usually more developed. In other species this same tectum presents itself as two sub-parallel blades, united by their inner edges, truncated and rounded anteriorly, and through which the body of the cephalothorax may be seen; in this last case the tectum has not any lateral expansions. If I notice these different modifications of the tectum it is because this eminently variable appendage is the best specific distinction that the *Oribatidæ* of the first division present."

Nicolet founds upon variations of the tectum, not only specific distinctions, but even those of sub-families. He describes it in several places, and evidently regards it as a chitinous shelf standing free in the air in many species, except that its basal edge is attached to the hinder part of the dorsal surface of the cephalothorax. This shelf, he says, has turned-up lateral edges in most species; these he sometimes calls the raised borders and sometimes the lateral wings of the tectum; for distinctness I shall give them a name, and I speak of them as the lamellæ.

I have always had great difficulty in distinguishing the species that Nicolet said had free tecta attached by their base only from those which he said had tecta attached by their whole under surfaces by this means of differentiation, but I presumed that Nicolet had satisfied himself that there was such a thing as a detached tectum, and it never struck me to doubt the existence of such an organ until I came to dissect for the purposes of the Ray book; had I doubted it, and trusted to inspection of the living creature, or of dead or mounted examples, I should probably have still considered Nicolet to be right, for certainly in such species as *Cepheus tegeocranus* (*vulgaris*), which is the very type of Nicolet's free tecta, it looks so very like what he described, that I not only should have been, but was, deceived; when, however, I came to dissect the organ away from the cephalothorax in this type species, I found, to my amazement, that there was not anything to come. I then passed a hair under the long projecting ends of the lamellæ, and

found that there was not any difficulty in carrying it back as far as the point where the tectum was supposed to commence, but there it stopped, and that nothing would get it any further, whereas it ought to have passed equally easily into the supposed space between the tectum and the dorsum of the cephalothorax (or vertex as Nicolet calls it). It then struck me that amongst all the very large number of specimens of *Oribatidæ* which I had examined I had not ever seen one where any dirt had got into this space, although it gets into every other place where there is a small hole or depression, and this would be a receptacle just fitted for it; but I thought that possibly a thin liquid, such as alcohol, or even water, might run in where a hair or solid matter would not pass. I accordingly tried, but could not get any to run under the supposed tectum; by these methods, but more especially by careful and frequently repeated dissection of various species, I at last became convinced that the tectum of Nicolet did not exist, and that the appearance of it in *Cepheus*, &c., was an optical delusion. In *Oribata punctata*, &c., the greatly enlarged and horizontal lamellæ somewhat simulate a tectum; this form is Nicolet's sub-parallel blades.

How does the appearance of *Cepheus*, &c., arise? It seems to me that the explanation is as follows:—The lamellæ are real and existing organs, easily seen by even the most superficial observer, and quite easy to get away, by cutting or breaking, but instead of being the upturned edges of a special, detached, horizontal, chitinous organ, they are simply outfoldings of the cuticle of the cephalothorax itself, just as the apodemata which serve as points of attachment for so many of the muscles, are infoldings of the same cuticle; in this manner it is natural that the base of each lamella should be thicker than its summit (or edge), which indeed does not include the true cuticle at all, but only the chitinous secretion from it, and the lamella, being a fold of the cuticle, does not spring sharply at right-angles from the surface of the cephalothorax, but rises in a curve, produced, so to speak, by the dragging up of the cuticle from each side; thus each lamella has a more or less triangular transverse section, the sides being curved and giving considerable extension to the base, *particularly on the inner side*. The dorsal surface of the cephalothorax, from which these lamellæ spring, is convex, and the broad inner base of the lamella filling up the depression caused by the lower part of the convexity, causes the whole space within the lamellæ to appear, and really to be, higher in level than the other parts outside the lamella. Again, the ends of the lamellæ usually rise forming projections, sometimes very short, but often of considerable length, which stand quite free. At the point where the lamellæ cease to be attached by their lower edges, and rise to form the free projections, the two lamellæ are

most frequently joined by a transverse ridge of the same nature, which, in some species, as *Oribata setosa*, *O. orbicularis*, &c., is large and conspicuous, almost as much so as the lamellæ themselves; in most species, however, the cross ridge is much smaller, often a mere line, and it has then the appearance of being the anterior edge of the supposed tectum; as it does not rise sharply on its posterior edge, but slopes up gradually, it would seem to be a natural result of the folding of the cuticle to form the projecting end of the lamella.

The last point I shall refer to is the exceptional mandible of one single species. The ordinary mandible of the family is a chelate mandible which, in all genera, except *Pelops* and the instance I am about to mention, is broadest in the middle and is terminated by a powerful chela (plate I. fig. 10).

In *Pelops* there is marked difference in the shape of the mandible (plate I. fig. 11): the base is broad, almost quadrangular, then the organ suddenly narrows and is continued as a long thin rod, terminated by a very fine chela; this doubtless fits it for exploring small holes. In every recorded instance the mandible is chelate, and this is given as a leading characteristic of the family.

One of Nicolet's species is *Leiosoma microcephala;* in external appearance it is but slightly distinguished from other species of the same genus. It is rare, and I had only two or three specimens; it is my habit to draw the mandible, but this necessitates breaking up the creature, and as they usually vary but little I did not like destroying a specimen; from what I could see, however, I suspected that there was something unusual in the trophi, and I sacrificed one of the three; to my astonishment I found a mandible (plate I. figs. 12, 13, 14), totally different from that of all other *Oribatidæ* which I know of; having somewhat the form of the *Pelops* mandible, but longer in the shaft (or thin portion), and curved instead of straight, but *not chelate at all*, on the contrary, devoid of any movable joint, and regularly serrated along the distal portion for a considerable length so as to serve as a sawing instead of a seizing or tearing organ. It seems to me that with this essential variation it is not possible to leave it in the genus *Leiosoma*, and I propose to create a genus to be called *Serrarius* for its reception.

Finally, I wish to express my thanks to Mr. Charles Stewart, of St. Thomas' Hospital, both for his encouragement to persevere in what I feared might prove to be investigations too difficult for me, and for his able opinions as to the results I had obtained; and also to Mr. E. Bostock, of Stone, and Mr. C. F. George, of Kirton Lindsey, for supplies of living specimens which enabled me to continue the research in London.

II.—*On a Minute Form of Parasitical Protophyte.*

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

(*Read 14th December*, 1882.)

Our knowledge of the minute forms of proto-organisms—pathogenic Bacteria, as they are frequently termed—which in some cases have been shown to be the cause, constituting the contagium, of infective diseases, has been greatly extended by recent advances in optical science, together with improved methods of preparation, and their presence has now been demonstrated where previously it was but suspected. Where recognized they were mentioned under general terms, without it being practicable to describe the characters which distinguished one form or species from another; whereas now we are often able closely to examine and measure some of the forms so as readily to discriminate and define them. There are others, however, so minute as to tax our best resources: such is the microphyte now offered to notice.

The preparation in which it is shown is a section of the lung of a mouse infected with a form of septicæmia, in which this organism appears to constitute the contagium. From a microscopical point of view a principal feature of interest here lies in the circumstance of its ultra-minute size, being, I believe, the most minute independent organism yet described.

The specific characters of this disease have been described by Dr. Koch in Germany * and by myself in this country.† It has not been observed to occur spontaneously, though there is every probability that it does so, inasmuch as the contagium in this case unquestionably originates in contamination from the atmosphere, and it is a significant fact that specific infection, or in other words, the occurrence of this organism in the putrid blood used for inoculation, is far more uncertain and rare in the winter months than in the summer and autumn. This is accounted for by the fact that the lower fungi or their germs are far more abundant in the air in summer than in winter.

In the section of lung shown occurs a large vein, in longitudinal section, in which amongst the red blood-corpuscles,‡ which are well preserved by absolute alcohol, there are seen several deeply stained round cells; these are the white corpuscles of the blood, somewhat swollen, and filled in varying numbers with the minute parasite here in question—in some, where not too crowded, they can be distinctly resolved; on the inner walls of the vessel too

* Untersuch. üb. d. Ætiol. d. Wundinfections-krankheiten. Leipzig, 1878.
† Quart. Journ. Micr. Sci., xxii. (1882) p. 60.
‡ Their diameter is about 1-4000th in, those of man being 1-3200th in.

they occur in vast numbers, and may also be recognized in most of the smaller blood-vessels or capillaries. The organism itself is a form of bacillus, the individual cells of which, allowing for foreshortening, are almost exactly 1 micromillimetre (0·001 mm., 1-25,000th inch) in length; that is, just the breadth of some common forms of similar organisms, septic and pathogenic Bacteria, as e. g. the hay-bacillus—*B. subtilis* of Cohn. Their breadth, by estimation, is certainly less than a fourth of the length, i. e. less than 1-100,000th of an inch. To examine and measure these accurately it is necessary that the blood containing them should be spread in a very thin layer on the cover-glass, dried and stained. In the tissues, thin and completely decolorized as the section here is, they cannot be sufficiently clearly seen for individual examination. Judging from the relative position and appearance of the cells, it probably possesses a flagellum; * and no doubt, as other bacilli do, it must form spores, though not perhaps in the tissues of the living animal, where its usual method of multiplication is evidently by fission. These spores would be mere points under the Microscope, circular bodies of only about the fourth or fifth of a micromillimetre, i. e. less than 1-100,000th of an inch in diameter.

The number in which these organisms may exist in the blood of an infected animal is incalculable; it may be even infinitely greater than in the case of Davaine's Septicæmia in the rabbit, where, as stated at a previous meeting of this Society,† I found that in some cases one drop of infected blood contained upwards of 3000 millions of them. In this case the blood is as infallibly infective as in the other, in the smallest quantities in which it can be taken on the point of a scalpel or a needle. I have not, however, been able to test its infectivity quantitatively, as in the former case, on account of the small size of the animal here, and the blood being invariably much coagulated upon death. It is a remarkable circumstance and one, I believe, peculiar to this disease, that the blood of an infected animal during life and within 18 hours, or even less, after inoculation, and previous to the occurrence of any apparent symptoms of disturbance, becomes itself infective, in as small quantities, and in all respects with similar results, as with inoculation by the blood of a dead animal.

* The flagella, if they exist, are probably mere filaments of homogeneous substance: very different from complex independent cells. Many microscopical objects are not distinguishable with our present means unless stained, either on account of their being of the same refractive index as the tissues (as in the case of the nuclei of cells), or on account of their minute size (as in the case of this microphyte), and the possible occurrence of others yet unobserved and perhaps unsuspected is suggested by Koch's remarkable discovery of the bacillus of tubercle, which, owing to the chemical reaction of its cell-wall, is not affected by the dyes which were previously supposed to stain all species of the Schizophytes.

† See this Journal, ii. (1882) p. 310.

A question often occurs as to the danger to man of infection with these highly virulent septic diseases. It may be said that in general they are only infective amongst animals nearly related generically. That Davaine's septicæmia in the rabbit is not infective to man, has been proved, accidentally of course; experimentally, too, it has been shown that it is not communicable to cattle, horses, or sheep. It is certainly not infective to dogs or cats, though readily so to guinea-pigs and mice. With anthrax, however, it is otherwise; that is virulently infective to man, amongst whom it is known in this country as wool-sorters' disease; cattle and agricultural stock of all kinds are liable to it, as are most rodents; also dogs and cats with difficulty; and amphibia and birds under certain artificial conditions, as has lately been shown. Mouse septicæmia, I have found, though others have asserted differently, not to be infective to other animals, either rodents or others.

All the circumstances of this affection, to some of the most prominent of which I have here called attention, are easily accounted for on the theory of the microparasitical origin of the disease, and as it appears to me on no other. As an objection to this view it has been asserted that specific pathogenic micro-organisms are normally present in the blood and tissues of healthy animals, and that they merely develope and multiply in the pathological or debilitated condition consequent upon inoculation with toxical matter. I have found this statement to be erroneous; the fact is that septic or putrefactive bacteria, as distinguished from pathogenic, are apparently normally present in the organs and tissues, which they invade, and develope in the blood, after death; to distinguish between these species is the province of microscopical observation. To the neglect and inaccuracy of this, which in some cases is very remarkable, is due much of the obscurity which still involves this subject, and has prevented the recognition of the relations of these micro-organisms.

On the discrimination of their distinctive morphological characters depend some of the questions which are of fundamental importance in bacterial physiology or, as the developing science has been more comprehensively termed, Schizomycology. In this view those engaged in investigating the subject look with warm interest to any improvement in the optical powers of the Microscope.*

* The description of this organism was illustrated by drawings showing the relative size and form of some different species of pathogenic and septic bacteria, under an amplification of 2800. The large forms were drawn by the camera lucida and a 1-16th water-immersion objective of Messrs. Powell and Lealand, with an eye-piece of about 3-4ths in. focal length used with the micrometer.

The objective with which the preparation was shown was a 1-20th homogeneous immersion of Powell and Lealand (1·38 N.A.) constructed specially for the examination of these proto-organisms, for which it is most admirably suited and invaluable.

III.—*On the use of Incandescence Lamps as Accessories to the Microscope.* By C. H. Stearn, F.R.M.S.

(*Read 10th January*, 1883.)

As for the last ten years I have not followed the progress of microscopical science, I cannot but feel that in venturing now to speak on microscopical subjects, I am in a similar position to that of a colonist who, on returning to his native land, finds that the world has moved on and left him far behind. Yet it is my hope that from those fields of research in which my thoughts have of late years been straying, and in which my former microscopical pursuits have been discontinued, I may have been able to glean some information which, though not primarily connected with microscopical science, may, in its practical application, prove of some utility to microscopists.

When, in 1871, I first commenced the study of the physics of high vacua, it was with the object of investigating the law governing the arrangement of the lines in the spectra of rarefied gases; but after my meeting with Mr. J. W. Swan, in 1877, I entered with him upon an investigation, having for its object the discovery of the conditions under which thin carbon conductors could be rendered permanent when made incandescent by an electric current in the most perfect attainable vacuum. With what success that investigation was attended, my colleague has already described in his lectures and pamphlets; and I presume that there are few here present to whom its practical results in the form of incandescence lamps are not by this time familiar.

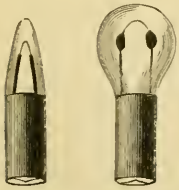
From a scientific investigation, the matter has now grown into a great commercial enterprise, and ere many months are over, there seems a probability that in many places gas will be entirely superseded by electrical illumination. When this happy time arrives, the application of the incandescence electric lamp to the purposes of microscopical illumination will certainly become universal, as it will then be not only the purest and most satisfactory light, but will be at the same time the most convenient. I hope, however, to show that microscopists need not wait for the realization of the hopes of the shareholders in electric companies, and the fears of those interested in gas companies, but may at once discard their troublesome oil or gas lamps, with many of their accessories, and proceed at once to avail themselves of the advantages of electric illumination. I am aware that Dr. Van Heurck, of Antwerp, has anticipated me in the application of our lamps to the Microscope; but, as those employed by him were of comparatively

large size,* the battery power necessary to render them incandescent would, till electricity is supplied from a central station, constitute a bar to their general use.

There can be no advantage in using a large light at a distance from the object, when a small one near to it will give as good, or better, results, and will at the same time require the expenditure of so little electrical energy, that the trouble attendant on the use of the battery is almost inappreciable; and in this way the lamp can be made a permanent attachment to the Microscope itself.

The lamps I have constructed for the purpose are shown full size in figs. 1 and 2, and *in situ* on the Microscope in fig. 3 at A B and C. The length of the incandescent filament is 1-10th of an inch, its diameter 1-166th of an inch, and its superficial area about 1-555th of a square inch. Two Bunsen or four Leclanché cells are sufficient to render them fully incandescent; but for general purposes it will be best to use an additional cell, regulating the intensity of the light by means of the adjustable resistance coil D interposed in the battery circuit and attached to the base of the Microscope.

Fig. 1. Fig. 2.



As the duration of the lamps is in an inverse ratio to the temperature at which they are maintained, it is desirable that the most intense light that the lamp will give should only be employed for a very short time when a special effect is required; such, for instance, as for purposes of micro-photography. If the lamp is at other times used no brighter than is necessary to obtain a white light, and the current turned off when observation is not going on, the lamps will last a very long time, as experience has shown that a life of more than 2000 hours of continuous and brilliant incandescence is frequently exceeded by Swan lamps. It is possible to obtain a light of $2\frac{1}{2}$ candles from the tiny surface just mentioned, with an electro-motive force of $3\frac{1}{2}$ volts, and a current of $1\frac{1}{4}$ amperes. It would, however, at a safe temperature, give a light equal to one candle.

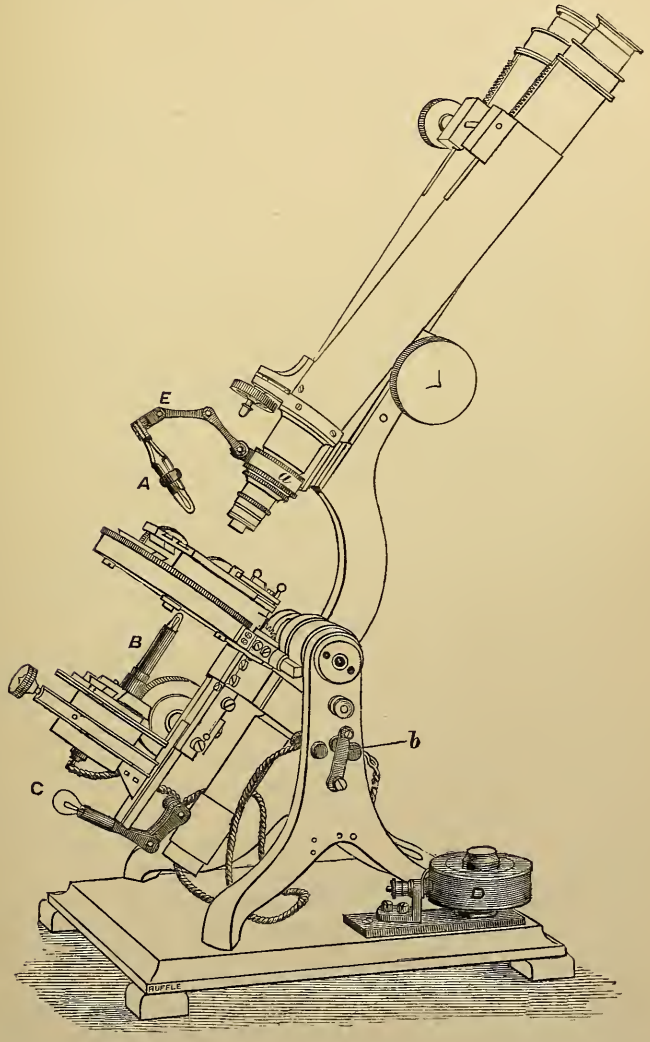
It will be found the most convenient plan to keep more than one, say three, of these lamps on the instrument, so that by merely turning a switch the position of the light may be varied.

(1) For the illumination of opaque objects the lamp A (fig. 3) is attached by a jointed arm E, to an insulated collar *a*, which screws on above the objective. The source of light can then be rotated around the object while under examination, so that delicate surface markings can be readily brought out.

* Since the above was written Dr. Van Heurck has informed me that he has used lamps requiring an electro-motive force of not more than 7 volts.

(2) On moving the switch *b* from the central position to the right, contact is made with another stud, and the current passes to a second lamp B, mounted on a platform fitting into the substage,

Fig. 3.



and capable of rotation and lateral adjustment, so that direct or oblique illumination at any angle may be obtained.

As the source of light is almost a point, and the lamp can be brought very nearly into contact with the slide, a greater degree of obliquity of the illuminating rays can thus be obtained than by almost any other method, and hence black-ground illumination is shown with great beauty, and many of the diatoms display diffraction colours with unusual splendour. The resolution of test objects becomes very much simplified, as most of them can be resolved by the lamp alone, without any accessory apparatus.

(3) For use with the polariscope, a third lamp C, of slightly larger size, is placed in the position of the usual mirror. It is put in action by moving the switch to the left, so as to make contact with the third stud. This lamp requires an additional cell so as to develope a light of about four candles.

As the sockets of the lamps are all made to a standard size, it is easy if more light be required than is given by the smaller lamp, to transpose the larger one to either of the other positions and use the full strength of the battery. If it is found desirable with the lower powers to give parallelism or convergence to the rays, a very small lens can be mounted in front of the lamp.

If a more simple mounting is desired, the forms shown in figs. 4, 5, and 6 may be adopted; and the lamp can be thus placed in any position above or below the stage.

If it is required to maintain the lamps for several hours at full incandescence, the most satisfactory battery to use would undoubtedly be a Bunsen or Grove. If, however, the switch is turned off whenever an observation is completed, a recent modification of the Leclanché answers admirably; for if exhausted through polarization it recovers itself when left for a short time, and will, when once filled, keep in good order for several months. It is best to use five of these modified Leclanché cells, controlling the strength of the current by means of the resistance, and diminishing it as the potential of the battery falls. For all ordinary work these Leclanché cells will be found to meet all the requirements of the microscopist. The Swan-Sellon, or Faure accumulator will also be found convenient, but these are at present rather expensive luxuries; and though they last for a considerable time when charged, the trouble of charging at intervals would probably counterbalance the advantages gained in other ways.

I have been able to light these lamps satisfactorily with a small dynamo, about five inches in length; and if it be possible to obtain a spring which can be wound up by hand, and will drive it for about half an hour without occupying too great a space, this may probably be a very convenient method of obtaining the current when required. When, however, we consider that to obtain the amount of electrical energy represented by the product of $3\frac{1}{2}$ volts and $1\frac{1}{4}$ amperes, we should have to expend about 4 or 5 foot-lbs. of mechanical

energy per second, the probability seems rather remote; and both for convenience and economy, the modified Leclanché cells carry off the palm at present, so far as microscopical illumination is concerned.

Fig. 4.

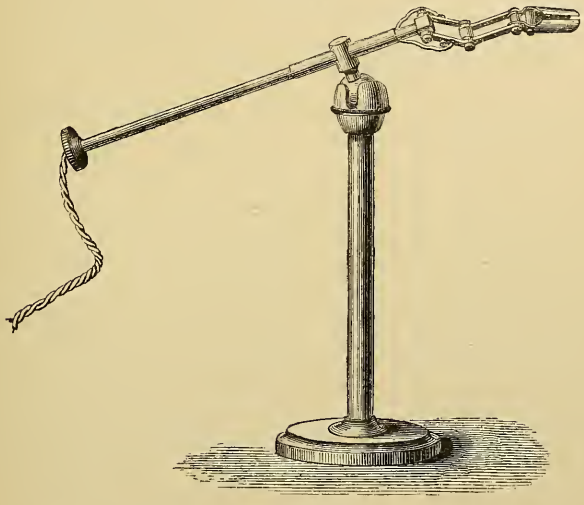


Fig. 5.

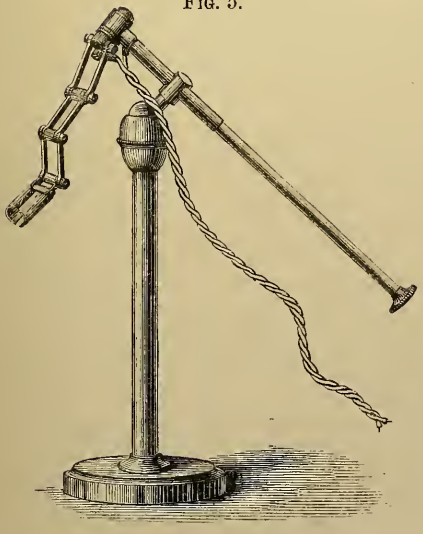
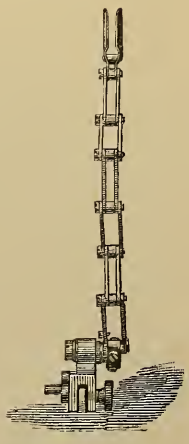


Fig. 6.



SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

Sudden Destruction of Marine Animals.†—Professor T. Rupert Jones accounts for the manner in which large numbers of marine animals have in past ages suddenly perished in their own element and been entombed: 1. (fishes) by either unusual or periodical influx of fresh water from the land; 2. by volcanic agency; 3. by earthquake-waves; 4. by storms; 5. (fishes) by suffocation, when massed together in frightened shoals, or when burrowing in sand and mud and accidentally buried by other sands and mud; 6. (fishes) by being driven ashore by fishes of prey; 7. (fishes and molluscs) by too much and too little heat in shallow water; 8. (fishes and molluscs) by frost; 9. (fishes) diseases and parasites; 10. (fishes and molluscs) miscellaneous causes: disturbance of equilibrium of living and dead organisms, ferruginous springs, poisons, lightning, &c.; 11. marine life surviving in fresh-water lakes.

Apparent Bird-tracks by the Sea-shore.‡—Mr. T. Meehan calls attention to what appeared to be the track of a three-toed bird in the sand, near low-water mark, at Atlantic City. They were generally regarded by observers as bird tracks. While looking at them, he noted that there were no birds about to make such recent tracks, and also that the tracks would have to be made in every case by a bird facing the water, which, in the nature of things, would be improbable. While reflecting on this, he noted on the face of the smooth receding waves, spots where the water sparkled in the light, and he found this was caused by little riplets as the wavelet passed down over the half-

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

† Geol. Mag., ix. (1882) pp. 533-40.

‡ Proc. Acad. Nat. Sci. Philad., 1882, pp. 238-9.

exposed bodies of a small crustacean, *Hippa talpoidea*, and that the water in passing over the bodies, made the trifid marks which had been taken for impressions of birds' feet. This little creature took shelter in the sand near low-water mark, and entered head foremost in a perpendicular direction downwards, resting just beneath the surface. The returning wave took some of the surface sand with it, and thus the lower portions of the bodies, uppermost in the sand, were exposed. Often the creatures would be washed out, when, recovering themselves, they rapidly advanced in the direction contrary to the retreat of the wave, and entered the wet sand again as before, their sides being parallel with the shore. The body terminated in a caruncular point which, with the position of the two hind-legs, made a tridentate obstruction to the sand brought down by the retreating wave, and the water passing around the points, made the three toe-like grooves which resembled a bird's foot from 1½ to 2 in. long. The creatures in their scrambles for protection beneath the sand, managed to keep at fair distances from each other, and hence there was considerable regularity in the tracks as if they had really been produced by birds.

He added that he presented the observation as a mere trifle, but he could not help remarking that if by any means these trifid impressions should get filled with mud, and the deposit become solid rock, it would be very natural for observers, ignorant of their origin, to mistake marks like these for the tracks of birds.

B. INVERTEBRATA.

Anastomoses of the Striated Muscular Fibres of Invertebrates.* —M. Jousset de Bellesme has endeavoured to determine the function of the anastomoses which are found in the primitive bundles of the striated muscles of Invertebrates, the same existing in Vertebrates only in certain special organs, such as the heart.

As the result of his observations on the larvæ of Insects and on Crustacea (more particularly Amphipoda and Isopoda) it appears first, that there is no necessary relation between the striated condition and the accomplishment of voluntary movements, as striated fibres are found in the digestive tube and its glandular appendages, and secondly, that there is a constant relation between the fact of this anastomosing and the mode of contraction of the organs which have this arrangement.

From the transparency of the Crustacea studied it was seen that the contraction of the fibres of the gastric cæca exactly resembled that of the Vertebrate heart. The products of secretion accumulate in the centre of these tubes and it is therefore essential that their walls should contract simultaneously (and not one part after another) in order to expel the secretion. It is this simultaneousness in the contraction that it is the function of the anastomoses to secure, and it is not without interest to see that the same effect is produced in the muscles of both Vertebrates and Invertebrates by the same organic arrangement.

* Comptes Rendus, xcv. (1882) pp. 1003–4.

Mollusca.

Digestion in Cephalopoda.* — E. Bourquelot continues his researches on this subject,† referring particularly to (1) the digestion of amylaceous matters and (2) of saccharose, (3) the function of the salivary glands, (4) the liver, and (5) the mechanism of digestion.

The food reaches the stomach direct; the crop of the *Octopus* seems to be only a kind of surplus reservoir; there it is subjected to the action of the digestive fluids which come from the liver and the pancreas passing by the cæcum. The proteid matters and the hydrocarbons are digested, the fats emulsionized, and the chyle goes directly into the intestine without passing by the cæcum. At the conclusion of digestion there is found in the cæcum and often even in the hepatic canals a small brown column which might be taken for digested food. It is, however, only a mass of hepatic cells detached from the gland. A similar column has already been noticed by Plateau at certain periods of digestion in the excretory canals of the abdominal gland of the Spiders.

Development of Bithynia tentaculata.‡—P. B. Sarasin, in his introduction, points out that although the embryos of this fresh-water Pulmonate Gasteropod are small and opaque, it is possible to make a good series of sections, in consequence of the comparatively small amount of yolk-material which is found in the endodermal cells. These are always sharply marked off, and have a distinctly cylindrical form.

The rounded yellowish ovum presents an elevation which appears to be, but is not, the point at which the directive corpuscle is extruded; indeed it is only as it disappears that the corpuscle is to be seen at the opposite pole of the egg. A period of rapid cleavage appears to be followed by one of repose; four larger polar cells are soon to be distinguished from a number of smaller ones; the gastrula, after formation, closes up again, and forms a complete and solid sphere—the *pseudogerm-sphere*. At its thickened part there arise two solid processes, one of which is distinguished by a slight depression on it, which soon becomes converted into the mouth. At this stage there is no indication of any velum; when the latter does come into existence it has at first the appearance of two rows of ciliated ectodermal cells. The process connected therewith forms the foot, while the other, by an ingrowth of cells, is the seat of the future shell-gland. The author, in opposition to the views of various embryologists, expresses his belief that in all Gasteropoda the original gastrula-mouth (blastopore) becomes closed up.

In the second section the velum, and primitive kidney (*ansæ*) are dealt with; the name of ansæ is applied to the chords of transparent vesicular ciliated cells, which are found inserted at the sides of the mouth, and which, in the embryo, have the function both of velum and of primitive kidneys; the author devotes some attention to demon-

* Comptes Rendus, xcv. (1882) pp. 1174-6.
† Cf. this Journal, ii. (1882) p. 30.
‡ Arbeit. Zool.-Zoot. Inst. Würzburg, vi. (1882) pp. 1-68 (7 pls.).

strating this point, and, in describing their later history, states that they at first so alter their position that the right one comes to lie almost in the middle of the neck; the left approaches towards the lower side, but does not come so near the middle line. This change in position is to be explained by the torsion of the anterior part of the visceral sac. In time the right ansa becomes altogether lost, while the left is finally an aggregate of ciliated cells, in which irregular cavities may be made out, and which are perhaps due to an internal destruction of the cells.

The liver is shown to be developed from the lower cells of the blastula, and from those which became invaginated to form the gastrula, and afterwards formed a solid sphere in the pseudo-gastrula. Invagination gave rise to two unequal portions, of which one remained solid, while the other was excavated and filled with fluid. The author finds that the whole of the enteric canal derives its elements from the ectoderm, while the liver is directly derived from the endoderm, its cells retaining throughout the whole of embryonic life the characters of true endodermal cells, distinguished by drops of deutolecithin; these last increase in size with the cells themselves, and filling them up, press the nucleus and protoplasm towards the outer wall; the more they aggregate in the cells, the more mucous substance is collected in the cavity inclosed by the hepatic sac. The two lobes of the liver, which are at first almost spherical, elongate considerably with the growth of the embryo.

The author is not able to demonstrate, though he is convinced of, the completely medioventral position of the developing enteron; at first the rudimentary intestine consists of nothing but a collection of ectodermal cells; later on a cavity is developed in them, and this pretty rapidly extends forwards and backwards; thus we get a tube bent at an oblique angle in the middle, and attached at either end. A little later, the fore-gut bends towards the left, and the hind-gut to the right side of the embryo; the former follows the hepatic lobes, just as these follow the visceral nucleus and all the organs. This torsion is easily explained on purely mechanical principles; an elastic cord growing regularly in length will, if its ends be fixed, form a loop by torsion through 180°; and thus tensions are avoided, which would otherwise affect it. This law is called the law of torsion, and would appear to be applicable not only to the phenomena observed in Gasteropods, but also in other animals, in no way closely allied to them. The body of the loop is formed by the widened portion of the hind-gut, which will become the stomach, and this portion is so twisted round that the anus comes to be near to, instead of at the opposite pole to, the mouth. A similar change in position is effected by the shell-gland.

The earliest rudiments of the nervous system are seen in what is now generally called the *trochosphere stage*. The following are the leading peculiarities of this stage in *Bithynia*:—The body forms a slight swelling towards the left side, the herald of the torsion; the intestine is slightly bent forwards, and lies towards the right hand; the fore-gut is hollowed out, and communicates with the buccal

cavity; the hepatic lobes are hollowed out, and the ansæ project considerably. The ventral surface is distinguished by the pedal process, at its anterior end. Right and left of the mouth there lie two ectodermal elevations, which may be known as the *sensory plates;* from these the cerebral and pleural ganglia of either side are developed; a ventral median growth gives rise from before backwards to two pedal, two visceral, and one abdominal ganglion. The first of these are only secondarily connected with the cerebral and pleural ganglia; the connection between the separate pairs was primitively effected by the median outgrowth, but this becomes lost, and a secondary connection takes its place. The pair of buccal ganglia arise from the œsophagus, and the olfactory ganglion is either developed on the right or in the dorsal median line. Attention is directed to the resemblances and the differences which obtain between the development of the nervous system of *Bithynia* and that of an Annelid.

The larval heart lies a little to the right side of the neck; the permanent heart may be seen to pulsate during its existence, but the pulsations are not synchronous. At the same time as that of the development of the nervous system, an ectodermal thickening on the right side of the embryo gives the first indication of the permanent kidney; under the effects of torsion, this organ comes in time to lie on the left side; at the same time, it elongates and becomes hollow. The pericardiac cavity is formed by mesodermal cells which become contractile, and from the solid cord of cells within it the permanent heart is formed; this lies almost perpendicularly to the kidney.

With regard to the germinal layers, the author tells us that the ectoderm is remarkable for never being at rest during the development of the embryo; all the organs are formed either directly or indirectly from it; the mesodermal elements do not arise at any definite and single point, and there is no evidence of any cleavage in it, and still less of the formation of a true cœlom. As the endoderm so called does not give rise to the enteron, its homology with the similarly named layer in the chick is to be doubted.

Many of the author's statements could only be made clear by the reproduction of a number of his figures.

Organization of Adriatic Chitons.* — B. Haller has examined chiefly *Chiton siculus* and *C. fascicularis.* Commencing with an account of the nervous system, he finds that, in the œsophageal ring, the primary pallial and pedal nerves form a connected whole, in which ganglia and commissures are not yet differentiated; any given transverse section exhibits a cortical layer of ganglionic cells, processes from which are either continued directly into the central nerve-plexus, or pass directly into the nerve-trunks. In the nervous system, and, especially, in the region of ganglionic cells, we may observe the well-known orange-yellow coloration, which is most intense where the cells are most largely aggregated. The nerves of the upper œsophageal ring either supply the cephalic portion of the mantle, or belong to the cephalic lobes, or innervate the lips, the epithelial layer

* Arbeit. Zool. Inst. Wien, iv. (1882) pp. 323-96 (8 pls.).

of the anterior buccal cavity, and the buccal musculature. Of the first of these there are no less than thirteen on each side, and, as it would seem, their function is mixed. There are the same number of nerves for the cephalic lobes, and they anastomose largely with one another. The third group supply the gustatory bulbs, among other structures. The commissures of the anterior visceral ganglia arise from the lower half of the œsophageal ring, and there is also a ganglion for the "subradular organ." After a detailed description of other parts of this system, which would be of interest only to those acquainted with the work of v. Ihering and Hubrecht, the author passes to the nervous supply of the heart and peritoneum. If pieces of fresh tissue from the auricle are placed in sea-water and then examined, large yellow pyriform cells may be seen between the muscular plexus of the heart. An aid to study was found in the use of a mixture of glycerine with a little acetic acid and water; the nerve-cells were then seen to have a very large nucleus and a distinct nucleolus; they are generally oval, and always have a protoplasmic process; they are placed between the epithelial investment and the musculature of the heart, where they form a fine nerve-plexus of small multipolar and large bipolar cells. Observations on the peritoneum appear to indicate the presence in it of bodies which are, physiologically, comparable to the Pacinian bodies of the Vertebrata.

In an account of the digestive apparatus, attention is directed to extremely delicate unilobular buccal glands, which are formed on its upper surface, and are not very easy to detect. Glands, to which the name of "sugar-glands" is applied, were found to open into the œsophagus, and to have a truly embryonic form, for they were simple outpushings of the enteric wall, with a single large lumen; the wall of the gland is remarkable on account of the development of villi on it. Variations in the colour of these parts are to be detected, and it appears that in the course of secretion the green colour is converted into violet, or, in other words, before the metabolic changes in the gland-cells can be effected, a chemical process is gone through, which finds visual expression in the alteration of colour. Another peculiarity is to be found in the fact that the secretory vesicles are not formed within the cell, but are excreted from it, without being visible, as such, within it. No definite information can be given as to the function of these glands. The epithelium of the stomach is distinguished from that of the œsophagus by the absence of cilia; into it there open, by separate orifices, the ducts of the liver, which consist of two unequal portions; the larger and lower portion, or that which primitively lies on the right side, is a large acinous gland, in which four several lobes can be made out. The most primitive arrangements possible are to be seen in the Chitons, for there are none of the longer efferent ducts, but the liver opens directly into the stomach; the lower wall of the upper portion of the stomach forms an infundibular invagination, and is gradually continued into the wall of the primary lumen of the liver; the orifice itself is not wide; the high epithelium of the stomach gradually disappears, and four or five circular folds appear in the infundibulum. Attention

is directed to the variations in colour of the liver of individuals of the same species of the Placophora; a lighter colour would appear to be associated with an absence of secretory activity, and observations were made which led to the conclusion that the brown pigment, which is at first regularly diffused through the protoplasm, disappears during the process of secretion; the drops of secretion are glass-green in colour.

After describing the other parts of the enteric tract, the author passes to the renal organ, which has lately attracted the attention of v. Ihering, who looks upon it as an unpaired structure; and of Sedgwick, who maintains its paired nature. Haller completely denies the presence of openings from the kidney into the pericardium, and supposes that the ciliated infundibular orifice becomes closed in the later stages of larval life—a view which receives support from an oral communication by Hatschek as to the course of development in *Sipunculus*. The kidney, but not its separate lobes, are invested by the peritoneum.

The heart lies under the 7th and 8th scales, and consists of a long median ventricle, which is prolonged anteriorly into the aorta, and of two auricles, which pass into one another posteriorly; it is here that they communicate with the ventricle. The cardiac musculature forms a plexus of many-branched anastomosing muscular bundles; in the auricles it is particularly thin, and the bundles may be there seen to consist of extremely delicate fibrils; the fibres are set parallel, except at the points where the bundles branch. There is no appearance of striation or of any investing layer. At the opening into the ventricle the muscles form a distinct valve. The musculature is not covered by any endothelium, but the muscles and the nervous elements are directly bathed by the blood. As the auricles are not set freely in the body, they are by that fact to be distinguished from the similar organs of other Gasteropods.

As to the course of the circulation, it is found that the blood is collected from the whole primary cœlom by a bilaterally disposed transverse lacuna, set a little behind that of the branchial vein; it passes into a longitudinal duct, which lies beneath the nerve-cord, and is set parallel to the long duct of the branchial vein. A rich lacunar system, in free communication with the primary cœlom, is to be found in the foot. When the blood is driven out of the ventricle it makes its way into the aorta, whence by simple openings (?) it passes into the primary cœlom, or, by pedal vessels, into the foot. The venous blood from the latter is driven, by its contractions, into the branchial artery, and so to the auricles. The blood-corpuscles are uncoloured.

The term secondary cœlom is applied to the cavity beneath the genital gland and the pericardium in which the liver and intestine appear to lie; owing to the reduction of the superior and inferior mesenteries, these organs have a closed investment. These partitions are, however, present on the rectum, and prove that there are two cœlomic sacs into which the digestive apparatus is invaginated.

The author concludes with some observations on the relation of

the Chitons to *Neomenia*, in which he opposes the doctrine of v. Ihering, that the former are derived from the latter, and holds that the two are separately evolved groups, related only by the possession of a common ancestor.

Generative Organs of Oysters.*—P. P. C. Hoek finds, as his most remarkable result, that the generative organs of oysters are not localized glands, but are distributed over the whole surface of the body; they are not separated from the integument on the sides of the body, and in front of the pericardiac cavity there is a dorsal and a ventral connection between the two halves of the organ. We everywhere meet with ramifications, which are in communication one with another, and have the internal wall forming internal culs-de-sac; the epithelial cells of these are converted into eggs or spermatozoa, both of which are produced from the same cell. The external longitudinal cleft, described by Lacaze-Duthiers, leads into a genital canal, which begins to ramify near the orifice; the branches ramify afresh, and extend over nearly the whole of the surface of the body. There is no trace of any genital papilla, and the orifice serves also for the organ of Bojanus. As to this last, the author states that it does not form a very distinct organ; it is composed of intercommunicating membranous folds, which open into a cavity lined by ciliated epithelium, and leading by a small canal to the urogenital orifice. In the wall of this cavity there commences a narrow canal, which runs almost parallel to the genital duct, and opens into the so-called pericardiac cavity. The author believes that the female products are often fertilized before they escape, and that the oyster is not only morphologically but also physiologically dicœcious.

Molluscoida.

Early Development of Salpidæ.†—F. Todaro, in his second preliminary communication, states that he has found that the follicle is divided into two sacs, which communicate freely with one another; one is at first much larger than the other, and may be known as the ovarian sac, as it contains the ovum during the whole period of its maturation; the other is very small and empty, and appears as though it were merely a small introflexion of the larger one. As the ovarian sac diminishes, it grows in size, so as to be able to receive the ovum, which remains in it during the period of segmentation. We may, therefore, call it the embryonic sac; it is provided with an organ of attachment, by means of which it is able to attach itself when it passes into the uterus.

The author does not now go into detail with regard to the various stages of the development of the ovum, but merely states that he has observed the entrance of a single zoosperm, its conversion into a male pronucleus, and its fusion with the female pronucleus to form the segmentation-nucleus; the nutrient material of the egg is obtained from the epithelial cells of the ovarian sac. The same

* Comptes Rendus, xcv. (1882) pp. 869–72.
† Arch. Ital. Biol., ii. (1882) pp. 1–9.

layer in the embryonic sac furnishes the nutriment for the first six blastomeres; these then proliferate, and give rise to small lecithal cells; segmentation is unequal, and division alternates with gemmation; the lecithal cells form a peripheral layer to the morula, and also extend inwards between some of the blastomeres; growing rapidly, they at last surround each of the fourteen blastomeres; they then penetrate into the blastomeres themselves, and those that do so disappear. At a later stage the blastomeres become broken up into small protoplasmic cells, which are only distinguished from the nutrient ones by the characters of the protoplasm; they soon increase greatly in size, and again increase by gemmation. Meanwhile changes are being effected in the sac, and we get in time to an embryo which, larger in size, rounded in form, and placed in the uterus, begins to be differentiated into its separate parts; the primitive intestine, the blastocœl, and the amnios are set up, and then the embryonic and blastodermic membranes begin to be developed. The essential parts of all the subsequent changes not here described in detail are stated to lie in the multiplication of the segmentation cells, and in the absorption of the lecithal cells, which serve to nourish them; on the ruins, as it were, of these latter the segmentation cells give rise to embryos; first of all, to the solitary, and then to the compound *Salpa;* in other words, there is a metamorphosis, and the details of the relations of the proembryo to the true embryos differ in different species, on the comparative study of which the author promises to enter on another occasion.

Compound Ascidians of the Bay of Naples.*—A paper on the anatomy and development of these animals by Dr. A. Della Valle is reported on by MM. Trinchese and De Sanctis. In the genus *Distaplia* Della Valle,† the colony is either sessile or pedunculate; the individuals are arranged in ramified masses resembling the *Didemnidæ*. The branchial sac has four series of openings; the stomachal walls are smooth; the heart is placed at the apex of the curve of the intestine; the sexual glands lie on the right side, somewhat above the heart; the testis is developed before the ovary and simultaneously in all the members of a colony, so that the colonies are always found either exclusively male or female. The mature ova are collected in the cloaca, whence they fall into a special diverticulum, which developes at this time and is subsequently detached from the animal. The larvæ are gigantic and produce buds; these are formed by a bending outwards of the external wall of the peritoneal sac, not far from the end of the endostyle; the bud soon separates from the individual which produced it and wanders towards the circumference of the colony, dividing by fission, and thus adding new individuals to the colony. Della Valle, dealing with the tail of the larva, finds by transverse sections that the axis consists of a cylindrical canal filled with a transparent liquid, which is perhaps

* Atti Accad. Lincei (Rome) Trans., vi. (1881) pp. 14-5.

† See this Journal, ii. (1882) p. 768, where an account of a paper on this genus is given from the author's description, differing somewhat from the present one.

identical with that which bathes the surrounding cellular structures; Kowalewsky and Kupffer had described the corresponding structure in some other Ascidians as a solid gelatinous body.

As observed by Hertwig, amœboid cells migrate from the ectoderm into the common mantle. A single Ascidiozooid was found to consist of an internal endodermal sac and of a bilobate peritoneal sac which communicates on one side with the endoderm by the branchial openings and on the other with the exterior by the cloacal tube; the muscular fibres lie between the outer lamina of the peritoneum and the ectoderm, as also do the heart and the reproductive glands; the products of the latter are transferred direct to the body-cavity. The existence of a mesentery and the method of development of the buds and of the embryo which results from the ovum, demonstrate conclusively that the Ascidians belong to the enterocelic type. The glandular character of the endostyle is confirmed. The circulation of the blood is wholly lacunar. Special attention is given to the reproductive organs of the compound Ascidians; in particular may be noted the formation of a special oviduct in the *Botryllidæ*, analogous to that of the *Salpæ*, and the remarkable form assumed by the testis in *Aplidium;* in the post-abdomen of the latter are found all the elements of the primordial body-elements, viz. ectoderm, endoderm, and peritoneal sacs. In a young Botryllid the nerve-ganglion was observed to be in direct connection with a prolongation of the ciliated fossa; the muscular system in this form consists of smooth fibres, placed between the ectoderm and the outer wall of the peritoneum. The processes of rejuvenescence and of formation of new individuals in compound Ascidians are described with great clearness. Metschnikoff's discovery of the origin of the bud of *Botryllus* from the parietal layer on the right and left sides is confirmed, and the formation of the enterocele described. In the simple Ascidians, the peritoneal sacs arise directly from the intestine and not from the ectoderm, as maintained by Kowalewsky.

New Division of Cheilostomatous Polyzoa.*—Dr. J. Jullien considers that a character of capital importance has hitherto been neglected by all authors, i. e. the ectocyst. The *Membranipora lineata* of Linnæus is constructed on an absolutely different type from that of *M. antiqua* of Busk, but both are united in the same genus with *M. calpensis*, which represents another type still, though derived from the second. Turning to the characters of the ectocyst we find in *M. lineata* a simple ectocyst that is not divided into two layers, and true avicularia; in *M. antiqua* there are two ectocysts, one external and the other (cryptocyst) internal, having between them a solution of continuity or *hypostegia*, no spinules but *onychocellaria* or false avicularia. To this latter type belong a number of cretaceous and some tertiary species which have hitherto been placed in numerous genera, according to the form of the zoarium. For the opening of the cryptocyst the author proposes the useful name "opesia," pointing out that the term "aperture" has been used both for the oral aper-

* Bull. Soc. Zool. France, vi. (1881) pp. 271–85 (5 figs.).

ture and for the large opening in the front of the calcareous wall of the Membraniporidæ, &c.

The author proposes to divide the Cheilostomata into two tribes according to the character of the ectocyst, adopting the view of most embryologists that the ectocyst of the larva produces the calcareous test of the zoœcium and the endocyst the polypide. We have then the two divisions of Monodermata (simple ectocyst) and Diplodermata (double ectocyst).

It is intended at some future time to examine all the families of the Diplodermata, but at present the author only deals with one which he calls Onychocellidæ. The type of this is *Membranipora angulosa*, which he re-names *Onychocella marioni* Jull., considering the onychocellaria to be of great classificatory value. The family is divided into eight new genera; these, however, seem largely based upon the figures in D'Orbigny's 'Paléontologie Française,' and we think that Dr. Jullien would sometimes find that the older portion and the growing part of the same specimen would have to be placed in separate genera, as the shape of the zoœcia and of the opesia is largely used as a generic character.

This is certainly a suggestive paper, and although all the conclusions of Dr. Jullien may not be accepted it may lead to several important characters receiving more attention, and the classification now in use may be much modified thereby.

New Type of Polyzoa—Cephalodiscus.*—Prof. M'Intosh describes a new type of Polyzoa allied to Allman's *Rhabdopleura* dredged in the 'Challenger' expedition, for which the name of *Cephalodiscus dodecalophus* is proposed.

It differs from *Rhabdopleura* in regard to the cœnœcium, in the much greater size of the buccal shield, in the remarkable branchial or tentacular plumes, in the structure of the pedicle, and in the perfectly free condition of the polypides. *Cephalodiscus* and *Rhabdopleura* agree in the absence of the calyciform membrane connecting the bases of the tentacles, in the position of the mouth, which opens ventrally behind the buccal shield, in the general structure of the alimentary canal, and in the position of the anus. The development of the young buds is similar. Both connect the ordinary Polyzoa with *Phoronis*. *Cephalodiscus* naturally falls under Professor Allman's section Polyzoa Aspidophora, and further demonstrates the correctness of that author's opinion in regard to the systematic position of these anomalous forms.

The following is the diagnosis of the genus:—Cœnœcium consisting of a massive irregularly-branched, fucoid secretion resembling chitine, hispid with long spines of the same tissue, and honeycombed throughout by irregular apertures, channels, and spaces, in which the separate and independent polypides occur singly or in groups.

Lophophore richly plumose, with an enormous buccal shield and large oral lamella, the mouth opening between the two. Anus on the interior dorsal prominence, behind the plumes. Two large eyes

* Ann. and Mag. Nat. Hist., x. (1882) pp. 337–48.

abutting on the ovaries. The homologue of the funiculus is short and quite free, its tip serving for the development of buds.

Vitality of Fresh-water Polyzoa.*—Dr. H. Allen calls attention to tenacity of life as exhibited in a fresh-water *Plumatella* (*P. vesicularia* Leidy). The leaf of the lily on which the colony had fixed itself, had been, by accident, removed from the water of the aquarium, and had been exposed for sixteen hours to the air. The animals had apparently become dry, and the colony itself barely visible to the unaided eye. Upon being again immersed (in water that chanced to be impregnated with iron-rust), the animals revived and flourished for two weeks, at the end of which time they perished from the effects of the decay of the leaf on which they were growing.

The following facts are of interest in this connection. First, that in these animals, relatively high in organization, aeration may go on for a number of hours by means of the retracted tentacles in the small amount of water contained within the cells. Second, that the presence of oxide of iron in the water does not interfere with the growth of the animals. And third, that the genus *Plumatella* may be found to resemble other mollusc-like creatures, not only in their plan of organization, but in their habits of sustaining life for long periods after removal of the animals from water. The last-named fact may possibly enter into questions of geographical distribution of this and allied forms.

Observations on Living Polyzoa.†—Mr. C. M. Maplestone describes observations made upon specimens either dredged, obtained from old piles, drawn up from the pier, or washed up on the beach. While some of those dredged, or carefully collected from the piles, and immediately transferred into bottles of sea-water, never expanded, many of those found on the beach and not expected to be alive did so. On filling a large bag with Polyzoa, and making a preliminary examination with a Coddington lens in the evening, some of the animals were found to be moving within the cells, and on transferring them to the zoophyte trough several species expanded. The author thinks it useful to mention this, as it may not be generally known that if Polyzoa are gathered soon after being washed up on the beach, or *before getting dry*, and are afterwards kept merely damp, there is a probability of finding them living, and he has often since found them so.

Arthropoda.

a. Insecta.

Polar Cells of Insects.‡—M. E. G. Balbiani has followed all the phases of the transformation of the polar cells in a *Chironomus*, and considers himself to be in a position to determine the precise significance of these elements. After tracing the process of development from their first appearance to the moment when the larva is hatched,

* Proc. Acad. Nat. Sci. Philad., 1882, pp. 223–4.
† Trans. and Proc. Royal Soc. of Victoria, xviii. (1882) pp. 48–51 (1 pl.).
‡ Comptes Rendus, xcv. (1882) pp. 927–9.

he points out that it is impossible not to recognize that we have to do with the generative organs of the animal, which have their origin in the polar cells. From this mode of development flow some interesting results with regard to the general morphology of the reproductive organs. There is first their very early formation, preceding that of all the other organs of the embryo, and indeed even that of the embryo itself in its most rudimentary form, the blastoderm. There is then the community of origin not only of the male and female sexual products, but of those and of the embryo. We may therefore say that the ovule, the spermatozoid, and the embryo have the fecundated ovum as their common origin; but whilst the latter is capable of being directly developed, the two former only acquire the aptitude for development by their reunion in a new fecundation.

Embryonic Development of the Bombycini.*—The type chosen by S. Selvatico to illustrate this subject is *Bombyx mori;* the ova of *Attacus mylitta* and *Saturnia pyri* were also examined. The following is the structure of the ovum at the end of winter:—(1) Solid globule, attached to an opaque substance on its inner aspect. (2) Transparent structureless membrane, considered by some as secreted by the blastoderm, but found by Tichomiroff before the appearance of the blastoderm. (3) Serous envelope, consisting of large, flattened, nucleated, polygonal cells containing pigment. (4) Nutritive yolk, forming large spheres which contain one or more protoplasmic nuclei. (5) Blastoderm, the ventral side turned outwards and covered by the amnion. The amnion appears as a membrane with large nucleated cells like those of the serous envelope, but without pigment. The Malpighian vessels originate in the ectoderm. Selvatico was perhaps prevented by the thickness or large size of the blastoderm in the above *Bombycini* from noticing the early appearance of the rudiment of the genital glands, which was observed by Balbiani in *Tinea crinella.*

Asymmetry of the Nervous System in Larvæ.† — Anna K. Dimmock, in dissecting a number of the larvæ of *Harpyia* (*Bombyx*) *vinula,* found that the nervous system, instead of extending in a direct line in the ventral region, as is common in insect larvæ, curved outward laterally between the first and second thoracic ganglia. This curving, which was toward the left in six larvæ examined, is to avoid interference with the duct from a sac, or gland, which opens out between the first and second thoracic ganglia. The gland secretes a liquid, said to contain salicylic acid, which the larva ejects, as a means of defence, when disturbed. The duct of this gland opens by a transverse cleft, figured by Müller,‡ on the ventral side of the first segment posterior to the head.

* Bollet. Bachicultura, viii. (1881) (7 pls.). Cf. Bull. Soc. Entomol. Ital., xiv. pp. 250–1.

† Psyche, iii. (1882) pp. 340–1 (1 fig.).

‡ O. F. Müller, 'Pile-Larven med dobbelt Hale, og dens Phalæne,' Kjobenhavn, 1772, pl. 2, fig. 3, *d.* Cf. also J. R. Rengger, 'Physiologische Untersuchungen über die thierische Haushaltung der Insecten,' Tübingen, 1817, pp. 35–6.

In the earlier stages of the larvæ the nervous system turns considerably out of the direct line, in order to allow the duct of the gland to pass; but, in the full-grown or nearly full-grown larvæ, it is nearly straight, although still distinctly unsymmetrical. This lessening of asymmetry, as the larva grows, is due to the duct being somewhat smaller in larger larvæ, in proportion to the size of the larva, thus allowing the nervous system to settle back, more or less, into its normal position.

This kind of asymmetry has not been found, the author believes, in any other Arthropod, but, upon the suggestion of Prof. Leuckart, she examined *Hirudo medicinalis*, the blood-leech, the nervous system of which has an analogous asymmetry. The genital organs are in such a position as to necessitate the pushing of the nervous system slightly to one side, near their outlet. Of four specimens of *Hirudo* examined, two had the nervous system to the right and two to the left of the genital organs; but of six specimens of *Harpyia* dissected, all had the commissure between the first and second thoracic ganglia deflected toward the left.

Vitality of Insects in Gases.*—From the apparent indifference of some insects to foul and poisonous emanations, as well as the varying sensitiveness of others under similar conditions, it would seem reasonable to conclude that there is a substantial difference in the delicacy of their respiratory functions, which might be indicated approximately by subjecting individuals of various groups to artificial atmospheres of delcterious or irrespirable gases. This opens a wide field of experimentation both in the methods employed, the reagents used, and the insects examined. More from curiosity than any other motive, Mr. L. P. Gratacap has made some trials in this direction, the results of which he tabulates, though they have not been extended enough to admit of any very interesting deductions.

The gases used were oxygen, hydrogen, carbonic oxide, carbonic acid anhydride, prussic acid vapours, nitrous acid fumes, chlorine, laughing gas (nitrous oxide), illuminating gas, and ammonia.

In oxygen the insects at first showed slight symptoms of exhilaration, "accompanied with a restless inclination to jump"; but this passed away, and they seemed totally unaffected by the excess of oxygen, and their vitality was impaired only after long exposure to its influence, due in some cases as much to the confinement. Flies (*Musca domestica*) lived 29 hours; Colorado beetles and meal bugs were confined 3 days, and then revived completely; *Phalangium dorsatum* lived 24 hours; *Noctua* 1½ day; and the common yellow butterfly (*Colias philodoce*) died in 12 hours, possibly as much from the effects of its own violence as from the gas. In hydrogen the flies were at once paralysed, and though apparently dead, were alive "for a long time" afterwards. *Noctua* and a black wasp died at once, but Colorado beetles evinced wonderful vitality, and revived thoroughly after almost 2 days' immersion. In carbonic acid anhydride, flies at once died, while Colorado beetles recovered after 3 hours' exposure,

* Amer. Natural., xvi. (1882) pp. 1019–22.

and after 45 minutes' exposure in carbonic oxide. Prussic acid vapours and nitrous acid fumes killed quickly, though the Colorado beetle resisted the attacks of the former more stubbornly than any other insect. Dense chlorine was also very fatal, but the beetles lived in an atmosphere overpoweringly odorous of it for an hour, and partially recovered on their release. In nitrous oxide the beetles lived 2 hours only, while the young of the common grasshopper (*Caloptenus femur-rubrum*) were confined 2 hours, and were but little affected; *Noctua* died in 1½ hour. In illuminating gas the beetles were instantly prostrated, but after an hour's immersion some recovered; croton bugs (*Ectobia germanica*) recovered after ½ an hour, the young grasshoppers after an hour, and flies after 5 minutes.

Mouth-organs of Sucking Insects.*—Basing his remarks on the *Aphidæ* and *Hemiptera*, and especially on the *Diptera*, Dr. K. Kraepelin, in a preliminary account of his investigations, finds these three groups distinguished by characteristic arrangements of their sucking-tube. In *Bombus* the tube is composed of the labial palps and the maxillæ, which are connected with them by strips of substance; near their lower margin the paraglossæ intervene between the palps and the maxillæ. The half-canal formed by the upward curve of the margins of the labium gradually disappears towards the posterior part of the latter, and allows liquid which has passed down it to escape between the labium and maxillæ into the mouth, at the point of origin of the paraglossæ. Besides the tactile hairs certain peculiar clavate pale hairs are placed on the apex of the labium, which appear from observations to be analogous to the olfactory hairs of the inner pair of antennæ of Crustacea, and as they carry a minute opening at their ends, must be considered as either gustatory or olfactory organs.

Like that of butterflies, the sucking-tube of the *Hemiptera* is made up exclusively of the two maxillæ, which unite in such a way as to form a double cylinder, the upper division of which carries the food, the lower the salivary secretion. The mandibles lie by the side of the maxillæ, and can move about on the tube. The end of the labium is provided with terminal nervous organs. In the proboscis of the *Diptera* the sucking-tube is formed mainly by the labrum, which consists of a demi-canal, closed below partly by the mandibles which are connected with it by a groove-and-ridge joint and partly by the hypopharynx, which runs below the mandibles, carrying the salivary canal; on each side below the hypopharynx lie the maxillæ.

Dealing with the mouth of *Diptera* at greater length, Kraepelin dissents from Dimmock's and Meinert's view, that the labrum is here made up of the labrum proper and the epipharynx; the paired organs described by Meinert in *Hippobosca*, &c., as an independently formed epipharynx, are here regarded as enormous developments of the cheeks. The muscles of the proboscis in *Musca* consist of—(1) Retractor of the fulcrum, and thus of the whole proboscis. (2 and 3) Extensor and flexor of the labium. (4 and 5) Elevator and depressor of the

* Zool. Anzeig., v. (1882) pp. 574–8.

labrum. (6 and 7) Upper and lower pairs of retractors and expanders of the labella. (8) An upper pair acting in opposition to 6 and 7. (9) Compressor of the end of each labellum. (10 and 11) Depressors of labial and labral channels respectively. (12) Band uniting apophysis of labrum to fulcrum. (13) Elevator and depressor of palps. (14) Dilator of pharynx. (15) Opener of salivary duct valve.

The "pseudo-tracheæ" of the labella appear to consist of a system of tubes, each provided with a narrow longitudinal slit, through which the saliva is rapidly spread over the surface of the labella, and which by the capillary action caused by their narrowness produce adhesion of the saliva to the surface; the tactile hairs of the labella are connected with nerve-endings; and between the "pseudo-tracheæ" are sunk double chitinous cylinders entered by nerve-endings, and probably to be regarded as taste-organs; a large salivary gland lies at the base of the labella. With regard to the pumping arrangements of the salivary glands and the sucking apparatus of the pharynx, the author supports previous observers. Large air-receptacles are placed in the fulcrum, labium, and head.

Scent-Organ of Papilio.*—Mr. H. Skinner has observed that the larvæ of *Papilio turnus* and *P. troilus*, when irritated, project from a slit in the prothoracic segment an orange-coloured bifid organ. The apparatus is a scent-organ, and gives out a strong and disagreeable odour perceptible at some distance, and seems to be designed to defend the caterpillar from numerous enemies.

The anatomy of the organ seems to have escaped investigation, as most authors merely mention its existence, one describing it simply as fleshy. It has the appearance of being a solid organ, but it is in reality hollow throughout the entire extent, and of very thin texture, tapering gradually to a point. It is drawn in by invagination, and is protruded after the same method. If the larva be held so that sunlight may pass through the extended organ, the progress of intussusception may be distinctly seen.

Anatomy of Aphides.†—E. Witlaczil describes the fat-body of the Aphides as being especially well developed in the abdomen, where it forms a thick layer under the skin; the large cells of this tissue contain a number of fat-drops, present in such numbers as to render the protoplasm and the nucleus scarcely recognizable in fresh specimens; the whole tissue has a spongy appearance. The fat-drops are often coloured green or red, and frequently greatly affect the coloration of the species. As in other insects, the musculature of the abdomen is divisible into a motor and a respiratory group; from the stigmata there pass up obliquely a group of two or three muscles, while a second group passes towards the middle line, and another muscle, attached a little behind the stigma, passes up backwards to the dorsal surface. There are nine pairs of stigmata; from the first a well-developed tracheal trunk proceeds forwards to supply the head, and

* Proc. Acad. Nat. Sci. Philad., 1882, p. 239.

† Arbeit. Zool. Inst. Wien, iv. (1882) pp. 397–441 (2 pls.).

gives off a number of branches. Three transverse anastomoses are to be found in the thorax.

The brain is proportionately large, and nearly fills the head; seen from above it is bilobed; and from the lateral lobes there arise the optic nerves. At the hinder end they are connected with a large cellular mass, which lies on the anterior end of the œsophagus, and is the frontal ganglion of the sympathetic nervous system. The median large lobes of the brain are continued backwards into two nerve-cords, which embrace the œsophagus, and unite below to form the sub-œsophageal ganglion. The large compound eyes contain numerous crystalline cones, pigmented at definite intervals; at the hinder margin three cones are separated off, and these, which are stronger but shorter than the others, are each surrounded by a continuous layer, and, with a projecting stalk, form an eye. In the apterous generations of *Pemphigus* the optic organ is solely represented by these three cones, the compound eye being aborted, in correlation with their mode of life. The number of joints in the antennæ have been wrongly used as a means of separating the genera; the author finds that there are constantly six joints, for in *Pemphigus* the winged forms have six and not five. The olfactory pits would seem to serve, not so much for finding the female as for detecting food.

In *Pemphigus bursarius* the separate wax-glands are found at equal distances from one another on the back and sides of the animal; on the prothorax there are four, on the meso- and metathorax and the first six abdominal segments, six, on the seventh there are four, and on the rest none. The glandular tubes, which form a projection into the body-cavity, have each a cylindrical lumen; the hollow wax-threads of one gland form a bundle; the development of these organs is found to be correlated with the abortion of the honey-tubes, and the habitation of galls by their possessors. The remarkable and characteristic sugar-tubes are placed on the fifth abdominal segment, and extend laterally to the hinder end of the body; they vary in form in different genera, and may be well used as a means of distinction. The hypodermis of the body is continued into them, and secretes a cuticle; the whole tube is traversed by a muscle which takes its origin from the hinder margin of the sternum of the sixth abdominal segment; by its contraction the tube is directed forwards, and some of the contained sugar-cells expressed. These last are of some size, and contain a finely granulated protoplasm, with nucleus and nucleolus; they secrete spheres, which, at first small, soon form a large, spherical, highly refractive and variously coloured mass. Under the influence of the air the sugar crystallizes into fine needles, which traverse the cell-wall and form a group outside it.

With regard to the sucking apparatus, the author is of opinion that the rudiments of the mandibles and first pair of maxillæ are not lost, but are sunk into the body, where they form the so-called "retort-shaped organs"; these, when fully developed, have an outer investment of flattened cells, which is continued into the epidermis of the body, and consists of a compact mass of pretty large nucleated cells, which secrete at the periphery a chitinous substance, which hardens

in contact with air and forms the seta. The sucking apparatus of Aphides has much resemblance to, but is simpler than that of the Coccidæ. After a description of the digestive apparatus and the Malpighian vessels, the author states that the dorsal vessel cannot be made out either in adult or in larval forms; in the embryo, however, as Mecznikow has shown, it may be recognized as a long tube, the wall of which consists of a single layer of small flattened cells, fused with one another; very thin muscular fibres pass, rather irregularly, along and obliquely across it.

With regard to the generative organs, the present investigations have led to results far from accordant with those of Balbiani; thus the "antipodal" cell could not be detected, but in an advanced stage of development a rounded protoplasmic-body at the hinder pole of the egg was observed to have the same characters as the peripheral protoplasmic layer. Germinal vesicles were on many occasions distinctly seen. The formation of the blastoderm proceeds from behind forwards, and cleavage is essentially equal.

Lampyridæ.*—H. Ritter v. Wielowiejski finds that:—

1. The tracheal end-cells discovered by M. Schultze are not, as their name implies, true endings of the respiratory tubules, for they ramify into still finer capillary tubes, in which the chitinous spiral support is absent; these latter are very long, and, invested by their peritoneal membrane, are largely distributed in the luminous tissue.

2. It is only comparatively rarely that the "tracheal capillaries" end blindly in the luminous organs; they more generally anastomose with one another, and form a kind of irregular plexus.

3. These structures do not, however, make their way into the interior of the parenchymatous cells, but extend richly over their surface, where they form irregular loops.

4. The "tracheal end-cells" are nothing more than the enlargement of the membranous peritoneal layer at the base of the tracheal capillaries, which radiate out from a trachea with a chitinous spiral; and the whole arrangement may be homologized with certain embryonal conditions of the tracheal system.

5. The "end-cells" do not form the seat or the starting-point for the development of the light. Although this phenomenon may first appear in their vicinity this is only because a large store of oxygen has been laid up in them.

6. The luminous property is essentially connected with the parenchymatous cells of the luminous organs, and is due to the slow oxidation of a substance formed by them, under the control of the nervous system.

7. The parenchymatous cells, from which the two layers found on the ventral luminous organs are formed, are exactly comparable in their morphological characters; and the difference between them is solely due to the chemical characters of their contents.

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 354–428 (2 pls.).

8. Some, if not all, of the parenchymatous cells are in connection with fine nerve-ramules.

7. The luminous organs are, morphologically, equivalent to the fat-body.

The author's most successful preparations were made with osmic acid, living and luminous specimens being placed in 0·1 to 1 per cent. solutions, or were subjected to its vapour; after washing with distilled water they were placed in alcohol or in a mixture of alcohol and glycerine. Good preparations were obtained by colouring with hæmatoxylin or picrocarmine, or by the methyl-green solution recommended by Mayzel and Strasburger.

It is of interest to observe that the author thinks that the layer of cells free from uric acid may become converted into an uric-acid series; and he bases this suggestion on the fact that the boundary line between the two is very irregular, and that the cells of the one set often project into the other; there is, too, a very considerable variation in the thickness, the dorsal being in some specimens much thicker than the ventral, and *vice versâ*. Physiological evidence is, however, still wanting to complete the proof.

The characters of the lateral luminous knobs found in the female of *Lampyris splendidula* are discussed, and it is pointed out that they occupy the only position in which it would be possible for their light to pass upwards and sideways; the organs of the larvæ of this species are distinguished from those of *L. noctiluca* by not being confined to one segment of the body, but existing over the whole of the abdomen; in structure they appear to be similar to those of the female, but they are smaller in size.

The adult species of *Lampyris* appears to be characterized by the frequent presence of organs which, in other Insects, are only found in the larvæ; as examples, we may cite the tracheal end-cells, and the large cells which lie almost freely in the body-cavity, instead of being united with tissues; so again in the fine, transversely-striated muscular fibres of the female of *L. splendidula* we find one or two large, clear, semilunar swellings, with granular contents and a large nucleus; these cannot be regarded as anything else than the remnants of the embryonic formative cells, from which the muscles have been differentiated. Yet again, the soft and wingless females are externally but little more highly developed than the larvæ. It cannot be doubted that the luminous power is a secondary sexual character, and its possession by the larvæ is perhaps to be explained by their poisonous nature, so that they warn the insects that might attack them.

β. Myriopoda.

Existence of a Blastopore and Origin of the Mesoblast in Peripatus.*—The late Professor F. M. Balfour was just before his death engaged in the preparation of a monograph on the anatomy and development of the members of the genus *Peripatus*, together with an account of all known species, and he left a series of notes, com-

* Proc. Roy. Soc., xxxiv. (1883) pp. 390–3. Cf. Nature, xxvii. (1882) p. 215.

pleted MSS., and drawings, which it is intended to publish in the 'Quarterly Journal of Microscopical Science' for April. His discoveries, however, on the early embryology of *P. capensis* are so interesting that a preliminary note has been communicated to the Royal Society.

The results are shortly as follows:—That a widely-open slit-like blastopore is formed in the early oval embryo, which blastopore, occupying the median ventral line, becomes closed in its centre, an anterior portion remaining open as a mouth, whilst a posterior portion apparently becomes the anus. The mesoblast is formed from the hypoblast at the lips of the blastopore, and makes its appearance as a series of paired hollow outgrowths from the cavity of the archenteron. This most primitive method of the formation of the mesoblastic somites, closely similar to that occurring in *Amphioxus* and other ancestral forms, is of the greatest morphological significance, and it is especially interesting to find that it survives in an entirely unmodified condition in *Peripatus*, the adult organization of which proves that it is a representative of an animal stock of the most remote antiquity.

Mr. A. Sedgwick, by examining some embryos in Prof. Balfour's collection of material as yet uninvestigated, has been able to confirm his results, and also by finding earlier stages to verify certain points in the developmental history which rested, at the stage at which Prof. Balfour's inquiry ceased, mainly on inference.

In the discussion which took place on the paper, Mr. Sedgwick pointed out the close resemblance of the early embryo *Peripatus* with open blastopore to an *Actinia*, the mesoblastic pouches corresponding to intermesenterial cavities, and the blastopore to the mouth, and urged that the discovery tended to confirm Prof. Balfour's published theory as to the origin of the bilateralia from the elongation transversely of a disk-like ancestor, the ventral nerve-cords having been formed by the pulling out into long loops of a circumoral ring. Prof. Lankester considered that the view that the blastopore represents a structure which in an ancestral form acted as a mouth, must be abandoned. The blastopore is very probably merely an aperture necessarily formed in the process of production of the hypoblast by invagination, and has never had any special function. Prof. Huxley also pointed out the essential difference between the peripheral nerve-ring of Hydromedusæ and a true circumoral nerve-ring.

Formation of Prussic Acid in a Myriopod.*—A foreign Myriopod occurring in hothouses in Holland, and identified as belonging to the genus *Fontaria*, has the power of secreting this substance. Attention was called to this animal by its emitting a distinct odour of oil of bitter almonds when excited; the odour is especially apparent when it is crushed. Maceration of specimens in water showed at once that the smell was due to this acid, it being detected in the water. A series of experiments have been made by C. Guldensteeden-Egeling to test

* Pflüger's Arch. f. Physiologie, xxviii. p. 576. Cf. Naturforscher, xv. (1882) p. 433.

the hypothesis that the Myriopod secretes a material which under certain conditions is decomposed and gives rise to hydrocyanic acid as one of its products; the hypothesis has been entirely confirmed. By the use of various reagents a body has been shown to exist which is broken up by water and yields HCy among the products of its decomposition. Further, it seems probable that the species in question contains another substance which acts as a ferment; this may perhaps be isolated by future experiments.

Embryology of the Chilopoda.*—N. Sograff's account of the earlier stages of the development of the egg of the Chilopoda is derived from a study of two species of *Geophilus* (*ferrugineus* and *proximus*, Koch) whose ova are better than those of *Lithobius* for the purpose.

The ova of *G. ferrugineus* have a fine ruby-red colour and are almost perfectly transparent; they are probably the same as those figured by Metschnikoff in his researches. Parthenogenesis appears to occur in this case, as males were not found at the end of April, but only females, of which three had empty receptacula seminis, whilst at the beginning of June eggs were produced by some of these females and commenced their development.

While in the oviduct the egg is enveloped in a transparent coat which appears to consist of the united chorion and yolk-membrane, for these structures can be distinguished in young ovarian ova. At this stage the egg is filled with yolk, hiding the germinal vesicle and yolk-nucleus; but on one occasion a nucleated mass of protoplasm —the nucleus being spindle-shaped, and exhibiting division of its chromatin into two groups of rods—was found in the centre, probably derived from the germinal vesicle. The nucleus and protoplasm divide into a considerable number of portions; the central cleavage-masses are round or polygonal, the peripheral ones stellate. Yolk-cleavage now takes place, the yolk breaking up into pyramidal masses, as in the *Decapoda*, these masses carrying portions of protoplasm upon their apices; the segmentation is not dichotomous; the number of pyramids was always the same and the only difference between the young and the perfect pyramid consists in an indefiniteness of outline in the apex of the former. The simultaneous origin of these masses is not an impossible circumstance, and is explained by the action of the central protoplasm in drawing in to itself the superincumbent yolk. The protoplasm-masses of the yolk now sink into the pyramids which form the primary endoderm, and the central protoplasm-masses come to the surface of the ovum and form the primary ectoderm. In the Chilognatha, judging from *Polydesmus*, the method of formation of the blastoderm more resembles that of the Crustacea and Arachnida; the yolk-cleavage appears to have been correctly described by Metschnikoff. The blastoderm of *Geophilus* consists at first of large, pale, very thin cells, dividing very rapidly, so as to form, in the course of 24 hours, a number of very small cells, which are, however, smaller on one side of the ovum than on the other; on this side the primitive

* Zool. Anzeig., v. (1882) pp. 582-5.

streak appears, beginning at its anterior end, which developes the first segments and appendages before the hinder portion is clearly defined. Before the appearance of the primitive streak the mesoderm is divided off from the small-celled ectoderm and at the same time nuclei, invested by masses of protoplasm, emerge from the yolk-pyramids and apply themselves to the mesoderm; these masses seem to be derived from the nucleus of the ovum and to have hitherto remained at the centre. The mesoderm, like the primitive streak, developes first in front. The conversion of the yolk-pyramids into endoderm, i. e. into the epithelium of the mid-gut, only takes place when the embryo is fully formed; it commences during that stage which Prof. Metschnikoff did not observe, and at the same time as the commencement of flexion of the embryo.

γ. Arachnida.

Poison-Apparatus of Scorpions.*—M. Joyeux-Laffuie finds that the poison-organ of the scorpion (*S. occitanus*) is formed by the last abdominal segment, where two small oval orifices serve for the exit of the poison: there are two glands, equal in size, and symmetrically arranged; each occupies a space, covered externally by the chitinous skeleton, and having internally an anterior and a posterior membrane, formed by striated muscular fibres, which are inserted into the chitinous skeleton. By their contraction the poison is forced outwards. The wall of the gland consists of a delicate layer, formed by cellular tissue and smooth muscular fibres: on its internal surface there are projecting lamellæ, which increase the extent of the secreting surface; below this, is a layer of prismatic cells, which are filled with protoplasm containing in suspension and in abundance fine rounded granulations, which are characteristic of the poison of the scorpion, and hide the nuclei, which only become apparent on the addition of acetic acid; these are the cells which elaborate the poison, and from which it escapes, by the rupture of the cells, into the central cavity of the organ.

Physiologically, this poison is very active, and that in direct relation to the quantity introduced; one drop is soon fatal to a rabbit, and still more active on a bird; seven to eight frogs may be killed by one drop, and the hundredth part of one is fatal to an ant of large size. It would appear to affect the nervous system, and has undoubtedly a marked action on striated muscle, suppressing spontaneous and reflex movement.

Snares of Orb-weaving Spiders.†—The Rev. H. C. McCook, accepting Thorell's arrangement of the true spiders into Sedentary (remaining for the most part in or upon their web and capturing their prey by means of snares), and the Wandering (hunting their food on the ground, the water, or trees), applies this principle of arrangement according to economy to the first section of the Sedentary Spiders—the Orb-weavers—which, whether "simply tentative, and in its present form incomplete, is given with the hope that it may lead to

* Comptes Rendus, xcv. (1882) pp. 866–9.

† Proc. Acad. Nat. Sci. Philad., 1882, pp. 254–7 (1 fig.).

something better, by fixing the attention of the very few students of our spider-fauna, among whom no such grouping has hitherto been proposed. Moreover, it is hoped that the arrangement may have some interest to naturalists generally as bearing upon the correspondence between structure and economy and the value of habit as a factor in classification."

An orb-web may be defined as a series of right lines radiating from a common centre, and crossed at intervals by other right lines attached at the point of contact and covered by viscid beads. Orb-webs are divided generally into vertical snares and horizontal snares, according as they are perpendicular to, or parallel with, the plane of the horizon. The vertical snares the author divides into (1) full orbs, (2) sectoral orb, (3) actinic orb, and (4) orb sector; the horizontal snares into (5) plane orb, and (6) domed orb. A table of these divisions is given, with sections and subsections, the former being mainly founded upon the character of the snare, as "simple" or "compound," and the latter being for the most part determined by the "hub" (the small open or meshed circle upon which the radii meet), which may be open, meshed, notched, &c.

Swiss Hydrachnidæ.*—Dr. G. Haller gives an account of the Hydrachnidæ found in Switzerland, with descriptions of twelve genera, including one new genus (*Forelia*, dedicated to Prof. Forel of Morges) and three new species.

δ. Crustacea.

Homologies of the Crustacean Limb.†—Dr. A. S. Packard, jun., commences by pointing out that, if we make a section of a typical Phyllopod, e. g. *Apus*, we see that the apparent bulk of the body is mostly due to the large size and nature of the foliaceous appendages; these have broad attachments, altogether different to the small anal articulations with which we are all familiar in the crayfish. The appendages of Crustacea may be grouped under four heads: they are sensory (pre-oral), masticatory (post-oral), locomotor (thoracic), or natatorial and reproductive (abdominal). In a table the author gives an arrangement of the appendages in the three sub-classes of Tracheata, and the two sub-classes of Branchiata. The antennæ of the Hexapoda are looked upon as the homologues of the mandible of the Arachnida, and the first pair of legs of the Merostomata; the second pair of antennæ in the Crustacea as homologous with the mandibles of Hexapods, the "chela" of Arachnids, and the "maxilla" of Myriopods.

The Cladocerous limb is thought to be intermediate between the Phyllopodous and Ostracodous limbs, and an ascending series may be seen from the Copepoda to the Ostracoda, and thence to the Phyllopoda. Hence, as the young of the Copepoda are all nauplii, and also those of the Phyllopoda, it follows that the ancestral form of all the Entomostracous Crustacea, as originally insisted on by F. Müller, was a nauplius-like animal. The characters of the Decapod

* MT. Naturforsch. Gesell. Bern., 1882, Abhandl. pp. 18–83 (4 pls.).
† Amer. Nat., xvi. (1882) pp. 785–99 (2 pls.).

limb are so different to those of the Phyllopod as to lead to the view that the Decapoda have risen from the nauplius independently of the Phyllopoda; and it would appear that the entire leg of the Phyllopod (without the gill and flabellum) is homologous with the endopodite of the Decapod maxilliped and the gill and flabellum with those of the Decapoda. The appendages of *Limulus* may be brought into relation with those of other Crustacea by appending an exopodite to the coxopodite, and arranging the gills on the outer side of a more or less cylindrical epipodite, instead of having them set antero-posteriorly. The author insists that radical changes of structure and changes in function may be seen in the Malacostraca, and he argues that still greater modifications may have obtained in the Palæocarides, of which *Limulus* is the sole survivor. The resemblances to the Arachnida are looked upon as merely analogous, and it is urged that the synthetic characters of *Limulus* may be shown to be very striking when a longitudinal section of it is compared with one of *Apus*; there may be seen such resemblances as the lobules of the liver filling the front part of the head, the oblique, long, narrow œsophagus, the position of the stomach under the eye, the simple archi-cerebrum, the general form of the heart, and the "gnathobases" near the mouth.

Characters of Nebalia.*—Dr. Packard also gives an account of the structure of *Nebalia*, a form which is of particular interest from "its composite nature," and its relation to some fossils which are generally regarded as Phyllopods. After an examination of the appendages the author points out that there is only a general homology between the thin, lamellar, thoracic foot of *Nebalia* and that of any Decapod; when the thoracic legs of the adult *Nebalia* are compared with the maxillipedes of the zoëa of the Decapods, a slight and interesting resemblance may be detected, but not so close a homology as between the maxillæ of the zoëa and the thoracic legs of the Phyllopods. In fine, the resemblances are so slight that we are forced to confess that *Nebalia* is not a Decapod. The form is, further, distinguished by the absence of a telson.

During the history of its development the diagnostic ordinal characters of the Phyllocarida declare themselves: the large movable rostrum, the compressed pseudobivalvular carapace, the lack of maxillipedes, the eight pseudophyllopod thoracic feet, and four pairs of abdominal feet, out of the six of the adult. *Mysis* does not seem to be descended from a Nebalioid, but from a zoëa-form. The Phyllocarida have had no Decapod blood in them, so to speak, but have descended by a separate line from Copepod-like ancestors, and culminated and even began to disappear before any Malacostraca, at least in any numbers, appeared.

Nervous System of Palæmonetes varians.†—A. Garbini describes the different parts of the nervous system and the sense-organs. Of especial interest are certain bodies found on the endopodites of the

* Amer. Nat., xvi. (1882) pp. 861–73 (3 pls.).

† Atti Soc. Veneto-Trentina, vii. (1882) (6 pls.). Cf. Bull. Soc. Entomol. Ital., xiv. (1882) p. 250.

antennæ where the tactile rods are placed in many Crustacea. They not improbably have an olfactory function here.

New Genus and Species of Lyncodaphnidæ.*—Mr. C. L. Herrick describes *Lyncodaphnia macrothroides* from Lake Minnetonka, Minnesota, the form of which is much as in species of *Alonella*, &c.: truncate behind; superior antennæ like *Macrothrix*, attached movably to the end of a blunt prominence beneath the head; second or swimming antennæ slender, four-jointed ramus with three long setæ and a stout thorn at the end of distal segment, the joint following the short basal one with a thorn above, the following joint unarmed; three-jointed ramus as in *Macrothrix*, the basal segment armed with a much-elongated seta; eye relatively small, pigment-fleck (*macula nigra*) present; *intestine twice convoluted*, expanded in front of the rectum, opening in the "heel" of the post-abdomen; post-abdomen slender, subtriangular, margined behind with a double series of spines; terminal claws large, and furnished with a long and short spine near the base; shell margined below by stout movable spines.

Few more interesting forms than the one forming the type of this very peculiar genus have been found, since it combines in a curious manner those characteristics hitherto regarded as distinctive of the families Daphnidæ and Lynceidæ. Kurz says,† "Keine Cladocerenfamilie bildet eine so streng in sich abgegrenztes natürliches Ganze, wie eben die Lynceiden," and this after recognizing the relationship of *Macrothrix* and *Lathonura* to the Lynceids, by placing them in the subfamily Lyncodaphnidæ. The form above referred to, however, has quite as close affinity to the Lynceidæ as to *Macrothrix*, though it resembles the latter rather more on a superficial examination; indeed, if one were to divide the animal back of the heart and examine the two portions independently, it would be impossible to avoid referring the head to *Macrothrix* and the body to some Lynceid genus. Thus is furnished another of those curious intermediate forms which remind us that the possibility of distinguishing families and genera, lies alone in the meagreness of our knowledge.

There can be no doubt that this genus should stand next to *Macrothrix*, but it will be necessary to modify a little the diagnosis of the Lyncodaphnidæ to receive it, and it then appears that it cannot longer remain a subfamily of the Daphnidæ, hence Mr. Herrick proposed to give it equal rank with that body and the Lynceids as an independent family, Lyncodaphnidæ, including the genera *Macrothrix*, *Lyncodaphnia*, *Drepanothrix*, *Lathonura* (= *Pasithea*), *Ilyocryptus*. As thus limited a very natural group is formed, in size and isolation corresponding well with the other related families.

Vermes.

Tubes of Sabellidæ.‡—E. Macé, struck by the great diversity of these structures in so homogeneous a group as the tubicolous

* Amer. Natural., xvi. (1882) pp. 1006–7 (1 pl.).

† 'Dodekas neuer Cladoceren nebst einem kurzen Uebersicht der Cladocerenfauna Böhmens,' p. 30.

‡ Arch. Zool. Expér. et Gén., x. (1882) pp. ix-xiv.

Annelids, has endeavoured to detect signs of a fundamentally identical structure. The tube of *Sabella penicillus* is formed of two parts, different in origin and in function; the former, which is external and accessory, is not secreted by the animal, but obtained from the surrounding medium; the other, which is essential and constant, is made by the Annelid; this is the tube proper. The very varying characters of the former are to be explained by the great differences in the nature of the surrounding medium, and this part of the tube may differ considerably in its different regions. When the materials for forming it are too large to be seized by the cirri the mucous portion is much thicker; at the same time it is to be observed that the animal economizes as much as possible its own secretion. The outer portion is very distinctly annulated transversely, apparently in correspondence with the segmentation of the *Sabella;* though it cleaves easily in all directions, it does not, owing to the structure of the inner layer, fall to pieces.

This inner layer is formed of a colourless hyaline substance, which swells considerably when macerated in water, and becomes hard and brittle by drying. During life it is perfectly flexible and very resistent. Sections are most conveniently studied in salt solution, as glycerine makes them too transparent. They are not modified in structure by the action of alcohol. A transverse section reveals the presence of concentric strata of some thickness; these may be broken up into very fine fibrils which swell, and rapidly become invisible under the action of reagents. On the inner side there is a very delicate granular layer, easily coloured by carmine. After maceration in water, an external and an internal membrane can be made out; these form a kind of sheath or cuticle, which resists the reagents which affect the median zone. The outer one is formed by large irregular plexuses, the bands of which have a fibrillar structure; the inner layer is continuous and is made up of excessively fine fibrils, crossing one another, but the majority have a longitudinal direction; among them there may be seen a large number of small hyaline rod-shaped bodies, similar to the so-called tactile organs which have been found in the integument of Vermes. The author compares this arrangement with the nematocysts found in the tube of *Cerianthus* by Haime.

The greater part of the tube is formed by the median zone; the layers, of which it is composed, vary in number and size proportionately with the thickness of the layer; the bundles which make it up give off anastomoses and prolongations, which traverse the spaces in the plexus of the outer zone. Chemical structures show that it is formed by an albuminoid substance, very near to, if not the same as, mucin, and it appears to be secreted by special glands which lie at the base of the branchial cirri. The calcareous part of the tube of *Serpula* is regarded as the homologue of the mucous part of the tube of *Sabella.*

North-Sea Annelids.*—G. A. Hansen, in Norwegian and English (in parallel columns), gives an account of the Annelids collected by

* 4to, Christiania, 1882, 53 pp. (7 pls., 1 map).

the Norwegian North Sea Expedition of 1876–78. He criticizes Malmgren's method of distinguishing and delimiting genera, of which he thinks he has made far too many and has used altogether unimportant characters; he points out that the pedal bristles do not differ in essential matters—"the type of the bristles is the same in all Polynoæ, with the exception of *Melœnis loveni* and *Polynoe scolopendrina*." The scales, in Hansen's opinion, are much more valuable, being characteristically constant in each species, and a study of them shows that Möbius and Tauber have gone too far in the opposite direction of "lumping" Malmgren's species and genera.

Tables of distribution are given from which it is evident that but few families of Annelids are absent from the frigid area, and the species are the same as those found in temperate waters; *P. globifera* alone indicates that its favourite, if not its sole, habitat is the cold bottom strata. As it is both coloured and provided with eyes it throws much doubt on the hypothesis of Ehlers that the deep-sea fauna has its numbers recruited from forms living in shallower water. Neither depth nor temperature appear to affect the development of Annelids. A number of new species are described.

Eclipidrilidæ.*—G. Eisen gives an account of a new Oligochæte which he discovered in 1878 in the Sierra Nevada; the specimens that he took down with him dying before he reached a Microscope, he scaled the mountains again in the succeeding year, so as to be able to make an investigation into the characters of its circulatory system on the spot.

The vascular system consists of two primary longitudinal vessels, of which the dorsal pulsates and is of nearly the same size as the ventral; there are secondary perigastric and gastric vessels, and the former are either connecting or free. The former of these are found in the anterior segments of the body, and connect the two primary vessels; the two last are longer than the rest, and supply the generative organs; they are none of them dilated into hearts, but they all pulsate slightly. The free perigastric vessels are placed in the more posterior segments, and are derived from the dorsal vessel; they pulsate slightly, and their inner end is free. The gastric vessels are found in the segments in which there are no perigastrics, and connect the dorsal and ventral vessels. Resembling, therefore, on the whole the vascular system of Tubificidæ and Lumbriculidæ, that of the Eclipidrilidæ is distinguished by never having gastric and perigastric vessels in the same segment. The blood is of a reddish yellow colour. The digestive system is a simple duct, just as in the Tubificidæ.

The testes form two saccular amorphous bodies in the 9th–13th segments, one on each side of the body; they contain numerous cysts of spermatozoa, but no free ones, and each cyst forms a globular body, with a round wedge-shaped tail; it is always covered by globules, which are either partly separate, or which run together forming beautifully elevated ridges, which in regularity and beauty can only

* Nova Acta Reg. Soc. Upsal., xi. (1881) 10 pp. (2 pls.).

be compared to the skeletons of certain diatoms. There are three pairs of very small ovaries, placed in the 3rd, 9th, and 10th segments; the oviducts appear to be represented by two very minute and delicate organs in the 9th segment; they are funnel-shaped, and the globular internal orifice is devoid of cilia. The efferent ducts are of enormous size, and each consists of two saccular ducts of nearly equal size, connected at the extremities by a short narrow tube, which is surrounded by spiral muscles; the longer of the two is the one which is directly connected with the body-wall, and it has near its inner end three very minute circular orifices. Inside this duct there is another, which is always full of spermatozoa, and evidently serves as a true seminal vesicle. "The total absence of efferent funnels is a characteristic of great value, not met with anywhere else in this class of worms, and which places *Eclipidrilus* in its decidedly isolated position."

The single known species is called *E. frigidus*, and has only as yet been found in the high Sierra Nevada of California at 10,000 ft. or higher. It is a true limicolide Oligochæte, with its closest relations with the Tubificidæ and Lumbriculidæ.

Ctenodrilus pardalis.*—J. Kennel, after a description of the external form of this Annelid, in which he directs attention to the variations in the arrangement of the setæ, describes the histological characters; the central nervous system, throughout its whole length, lies in the epidermis, and exhibits the very simplest arrangements, comparable more to what is seen in *Polygordius* and *Saccocirrus* than in any higher form. The supra-œsophageal ganglion is formed by a transverse bridge of fine dotted substance, in which no fibrous bands are to be detected, and of surrounding ganglionic cells, which are collected into two lateral groups, without, however, being sharply separated off from the epithelial cells. On either side, the dotted substance of the ganglion is continued into a fine commissure which traverses the epidermis and becomes connected with the ventral medulla; these bands appear to be devoid of any ganglionic investment. The ventral cord presents very much the same histological characters as the dorsal ganglia, for, just below the basal membrane of the epithelium, there is a fairly well developed cord of dotted substance, with cells at its sides, which pass without any distinct demarcation into the epidermal cells, between which and them no absolute difference can be said to exist. No peripheral nerves were detected, but, though their absence is not to be assumed, there would appear to be no absolute necessity for their existence; inasmuch as it is probable that here, as in many of the lower animals, the elements which form the tissues have many of the properties belonging to a simple living cell, and, among these, irritability. The only sensory organs are the two small ciliated pits which are placed at the sides of the cephalic lobe, on the dorsal ganglion; their depression is very shallow, and only a few cells take part in their formation.

Similarly, a great simplicity is to be seen in the musculature; immediately below the fine basal membrane of the epidermis there is

* Arbeit. Zool.-Zoot. Inst. Würzburg, v. (1882) pp. 373-429 (1 pl.).

a single layer of longitudinal muscular fibres, which are not divided into areæ, though they are found at regular distances all around the animal. The mesodermal tissue between the musculature and the enteron is, likewise, very slightly developed; in connection with the peritoneum there is a thin layer of small cells in which gemmation may be seen; this, which may be looked upon as undifferentiated mesoderm, is most largely developed in the region of the dissepiments.

The stomach and intestine are formed by a single layer of large epithelial cells; all the cells of the intestine are ciliated. The circulatory system is not closed, and presents a greater simplicity than that known in any other Annelid; a thin membrane, with scattered spindle-shaped nuclei, forms the wall, and has no thickenings or additions even in the dorsal contractile portion; on the other hand, we find in this dorsal vessel a solid cord of cells, the function of which must remain very obscure, unless we are allowed to regard it as a hæmatopoetic organ; it may be compared with the structure noted by Claparède in *Terebella*.

There is but one pair of segmental organs, lying directly behind the pharynx, and, as it seems, in the first, or, at least, in the second segment. Their walls are extraordinarily thin, and their lumen of pretty much the same width throughout.

The account that has been given will be sufficient to show that in *Ctenodrilus* we have to do with an ancient and "collective" type which exhibits affinities to the Oligochæta on the one hand, and the Polychæta on the other; the very forward position of the segmental organs forbids us to look upon it as a degraded form. For its reception there may be formed a family *Ctenodrilidæ*, consisting of small marine Annelids, of a few segments, with two pairs of setæ, a non-closed blood-vascular system, the dorsal vessel lying in the first body-segments, and opening into the cœlom in the first trunk-segment. A single pair of segmental organs in the head. Reproduction by division with gemmation. Sexual reproduction unknown. *Ctenodrilus* and *Parthenope* the two known genera.

The rest of the paper is occupied by an account of the phenomena of gemmation.

Distichopus.*—Prof. J. Leidy describes a new genus of Annelids—*Distichopus*, closely allied to *Enchytræus*, but with setapeds in a single row on each side ventrally, and not double as in the former genus.

Turriform Constructions by Earth-worms.†—In his work on worms, Darwin has described some tower-like dejections which he never saw constructed in England, but which are attributed to an exotic species of *Perichæta* from Eastern Asia, naturalized in the environs of Nice. E. L. Trouessart has lately observed similar dejections in gardens near Angiers. Having collected a large number of worms from where the towers were made, he found no species of *Perichæta*, nor of any other exotic genus. In two or three cases he surprised the worms at work, and they were *Lumbricus agricola*.

* Proc. Acad. Nat. Sci. Philad., 1882, pp. 145–6.
† Comptes Rendus, xcv. (1882) p. 739.

It was the anterior part of the body that was lodged in the tower. After the rainy period at the end of September all the tubular interior of each tower (forming a continuation of the subterranean gallery) was quite free; but a few days later it was obstructed by recent dejections. M. Trouessart supposes that the calotte or cap of the tower, getting hard in air, a time comes when the worm can no longer burst the upper wall as before, to place its dejections outside (so increasing the height of the tower), but deposits them within. Thus a long period of rain is necessary for these towers to rise regularly. The towers probably serve to protect the galleries from rain, and to afford a breathing place for the worms, where they are not seen by birds.

Hamingia arctica.*—This remarkable Gephyrean was first described by Koren and Danielssen † from a spirit specimen, and subsequently by Dr. Horst ‡ from two sent to him. Prof. E. Ray Lankester having obtained a fresh specimen as well as one in spirit, is able to add to our knowledge of its character. He finds it is really intermediate in its combination of characters between *Bonellia* and *Thalassema*. Owing to their not having known the frontal hood or proboscis, Koren and Danielssen somewhat over-estimated the closeness of its relationship to *Bonellia*. On the whole it may be said that *Hamingia* has in internal organs a closer resemblance to *Bonellia*, but in external shape and characters a closer resemblance to *Thalassema*. The feature in which it is quite peculiar is the absence of genital setæ in the female and the correlated existence of one or of two prominent papillæ which carry the genital pore or pores.

The new facts recorded, additional to the observations of Koren and Danielssen and Horst, are briefly as follows:—

1. *Hamingia arctica* occurs on the Norwegian coast in latitude 60°, and at the comparatively small depth of 40 fathoms.

2. It has a frontal hood or proboscis resembling that of *Thalassema*, which is easily broken off, as in *Thalassema* and *Echiurus*.

3. The corpuscles of the perivisceral fluid are coloured by hæmoglobin.

4. The male (five of which, 1-12th in. long, were found within the dilated pharynx of the female) is a diminutive parasite living upon the female, as in the case of *Bonellia*; it is provided with a pair of large genital setæ, although such setæ are absent in the female.

5. Though usually there are two, yet there *may* be only one uterus, and one genital pore, as in *Bonellia*.

Anatomy of Prorhynchus.§—J. v. Keunel discovered specimens of *Prorhynchus* in the neighbourhood of Würzburg, and has also examined examples from other localities. Unlike M. Schultze, who regarded it as a Nemertine, v. Keunel looks on this genus as belonging to the Rhabdocœla; the first point in favour of this view is the character of the digestive tract; the mouth lies at the most anterior end of the

* Ann. and Mag. Nat. Hist., xi. (1883) pp. 37–43 (2 figs.).
† Cf. this Journal, i. (1881) pp. 45, 890.
‡ Ibid., p. 891, and ii. (1882) p. 50.
§ Arbeit. Zool.-Zoot. Inst. Würzburg, vi. (1882) pp. 69–90 (1 pl.).

body, and, in life, is a circular orifice largely capable of extension and contraction. The œsophagus is narrow and thin-walled; the pharynx, which is strongly muscular, may be elongated or shortened, or protruded through the mouth; in histological characters it agrees generally with the same organ in many Rhabdocœles, e. g. *Derostomum*. The intestine makes but feeble curves, and ends blindly at the hinder end of the body.

No less do the other characters—external covering, musculature, and so-called body-parenchyma—tell the same story of zoological affinity. The ciliated body-epithelium is composed of polygonal flattened cells, with finely dentated margins. Below this there is a single layer of longitudinal fibres, and then one of circular fibres, which is likewise single; none of the fibres have a nucleus, and they are all very long and fine. The parenchyma is very feebly developed on the hinder part of the body, or region of the true intestine; anteriorly it presents a cellular structure with a number of nuclei, and between these, especially in the most anterior region, there are large vesicular spaces, which permit of the contractions of the body and the protrusion of the œsophagus, and copulatory organ. The body-wall appears to be remarkable from being traversed by numerous efferent ducts from small unicellular glands, which lie within the musculature, and are to be regarded as modified epidermal cells; they are perhaps homologous with the rod-cells of other Turbellaria.

The nervous system is in every way that of a typical Turbellarian; the cerebrum lies *in front* of the pharynx, above the œsophagus; it consists of three ganglia, which are not sharply separated from one another; one is median to the other two. The latter give off two longitudinal nerves, which are altogether devoid of ganglionic cells, and which very soon become thin; they probably reach to the hinder end of the animal. All these ganglia give off groups of ganglionic cells anteriorly; the dorsal series extend almost to the anterior end of the body, while the lateral pass to the lateral pits of the head. The brain of *Prorhynchus* is, then, to be distinguished only from that of other Rhabdocœla by the fact that the commissure is covered by ganglionic cells. The first-mentioned pits have a narrow orifice and are somewhat pyriform in shape; the longer cilia which invest them are placed on a fringe formed by fused epithelial cells. Such pits are known in certain Rhabdocœles, e. g. *Microstomum* and *Stenostomum*, &c.

Although *Prorhynchus*, like the majority of known Rhabdocœla, is hermaphrodite, there is some reason for supposing that the male are mature before the female products; the male organs consist of a protrusible penis, connected with a ductus ejaculatorius, which, after coils that vary with the state of contraction of the animal, passes to a thin-walled seminal vesicle; the whole apparatus is ventral in position, and ought not, therefore, for a moment to be compared to the proboscis of the Nemertinea; the male glands lie behind the vesicle, on either side of the intestine, where they have the form of small rounded follicles, without special walls; they are filled with finely granular cells of various sizes, intermixed with ripe spermatozoa. The larger of the cells often contain two nuclei, and are peripheral in position; the smaller

cells are the products of their division. The female germ-gland forms a band-shaped organ, which lies beneath the intestine, and consists at its hindermost end of indifferent, and at its anterior end of ovarian, cells. The female orifice lies in the ventral median line, and there is a feebly developed vagina, with which are connected some glandular cells. The female organs are, on the whole, as much of the type of those of other Rhabdocœla as are the male.

The excretory system opens, at the level of the female pore, on either side of the body; connected with this is a short terminal canal with firm contractile walls. For other points reference is made to the accounts of earlier observers.

The paper concludes with the description of *P. balticus* n. sp.

Monograph on the Turbellarians.*—Prof. L. von Graff has published a splendid monograph of this group, founded on elaborate personal investigations.

Separating the Nemertines altogether from the Turbellarians, he divides the group into I. Rhabdocœlida, and II. Dendrocœlida. In the definition given of the two sub-orders, an interesting point of difference is brought out, namely, that in the former the yolk-glands are always present in the form of a pair of compact glands, whereas in the latter they are always divided up into numerous separate follicles.

The Rhabdocœlida are divided into three groups:—(1) Acœla; (2) Rhabdocœla; (3) Alloiocœla, which are thus defined:—

(1) Acœla. With digestive internal substance; without differentiation of a digestive tract and parenchym tissue. Without nervous system or excretory organs. All forms as yet known provided with an otolith.

(2) Rhabdocœla.—Digestive tract and parenchym tissue differentiated; a roomy body-cavity usually present, in which the regularly shaped intestine is suspended by a small amount of parenchym tissue. With nervous system and excretory organ. Generative organs hermaphrodite (except in *Microstoma* and *Stenostoma*). Testes, as a rule, two compact glands. The female glands present as ovaries only, ovario-vitelligenous glands, or separate ovaries and yolk-glands. Genital glands separated from the body parenchym by a special tunica propria. Pharynx always present and very variously constructed. Otolith absent in most cases.

(3) Alloiocœla.—Digestive tract and parenchym tissue differentiated, but the body-cavity much reduced by the abundant development of the latter. With nerve system and excretory organ. Generative organs hermaphrodite, with follicular tests and paired female glands, either ovaries only, or ovario-vitelligenous glands, or separate ovaries and yolk-glands. Yolk-glands irregularly lobular, rarely partially branched. Genital glands almost always without any tunica propria lodged in the spaces in the body parenchym. Penis very uniform, and either without chitinous copulatory organs, or with

* Graff, L. von, 'Monographie der Turbellarien. 1. Rhabdocœlida.' Fol. Leipzig, 1882, 12 figs. and 20 pls. Cf. Prof. H. N. Moseley in 'Nature,' xxvii. (1883) pp. 227–8.

these very little developed. Pharynx a pharynx variabilis or plicatus. Digestive tract lobular, or irregularly broadened out. All marine except one, or possibly two species. (Under the Alloiocœla come the genera *Plagiostoma*, *Vorticeros*, *Monotus*, and others.)

The work commences with a complete list of the literature on Turbellarians from the time of Trembley, who, in 1744, figured a black fresh-water Planarian, to that of the publication of the last of Dr. Arnold Lang's important memoirs last year. The list is followed by a general treatise on the anatomy and physiology of the Rhabdocœlida. The account of the nematocysts of some forms is very interesting; their exact resemblance to those of Cœlenterata is fully borne out. *Microstomum lineare* appears to be the only species which, like *Hydra* and *Cordylophora*, possesses two kinds of nematocysts. The author thinks he has been able to detect on the surface of the cuticle, trigger hairs in connection with the nematocysts, like those in Hydroids. He considers the rhabdites or rod-bodies homologous with nematocysts, and refers, in connection with this question, to the nematocysts devoid of any thread which occur in many Cœlenterates, intermingled with fully developed ones. The structure of the pharynx is carefully gone into, and its different forms being of much use in classification, receive various names, such as *Pharynx bulbosus*, *P. plicatilis*, &c.

The water-vascular system has been studied by von Graff with considerable success. It may consist of a single median canal with a single posterior opening (*Stenostoma*), or a pair of laterally placed canals with a similar single opening or two separate lateral canals with each a posterior opening (*Derostoma*), or there may be a pair of openings or a single one somewhat anteriorly placed. Ciliated funnel cells or flame cells, such as exist in Cestodes, Trematodes, and Triclad Dendrocœles, have been discovered by von Graff also in the Rhabdocœlida. They do not, however, occur in connection with the tips of the ramifications of the water-vascular canals, but almost entirely on the larger canals forming the networks. It is impossible here to follow the work further, through the interesting sections devoted to the development of *Microstoma* by budding, and the habits of life and distribution of the Rhabdocœlida. In connection with the discussion on classification, a table of the pedigree of Turbellaria is given, with *Proporus* as the ancestral starting-point. In this family tree the Dendrocœles are shown as derived from *Acmostoma*, a new genus of Alloiocœla, characterized by having a distinctly marked narrow ambulacral sole, the Polyclades directly, and the Triclades through *Plagiostoma*. The ascertained facts as to the structure of Turbellarians seem to point even more closely to their connection with the Cœlenterata. The presence of two kinds of nematocysts in one of the Rhabdocœla, and the possible occurrence in members of that group of trigger hairs, is a remarkable fact. Dr. Lang, believing that a part of the nervous system in Dendrocœles is truly mesenchymatous, as in Ctenophora, and from other grounds, concludes with Kowalewsky that the Polyclada are "creeping Cœlenterates which have many points of structure in common with the Ctenophora, some with the Medusæ." Such being the case, naturalists wait with great impatience

Kowalewsky's promised further information as to his extraordinary *Cœloplana*, supposed to be intermediate between Ctenophora and Dendrocœlida. The peculiar azygos character of the otolith in so many Dendrocœlida may perhaps be explained by the similar condition of the sense-organ in *Cœloplana*.

Whether the second part of the work, dealing with the Dendrocœlida, will be published or not depends upon the extent to which Dr. A. Lang's forthcoming work may cover the same ground.

Dinophilus apatris.*—E. Korschelt gives a full description of this new species of Turbellarian. After a short account of the known species, and the characters of the new one, as drawn from the female, he describes its habits, as observed in a marine aquarium. The body is covered by an epidermis, which consists of a layer of irregular polygonal cells; there would appear to be no rods, but, more especially in the young, we may see a number of small rounded bodies, which have the same refractive index, and possibly are comparable to them. From these cells there arise cilia, some of which are shorter than the others; the former are arranged in eight regular rings, and of the latter two well-marked pairs are to be seen at the anterior end of the head, with others on the tail and on the dorsal surface. From their position we may justly assume their tactile function.

The expression body-space is expressly used for the purpose of marking the difference between it and the body-cavity of the "Enterocœlia"; it is a wide cavity, such as is seen in no other Turbellarian, and is traversed by only a few very fine connective bands, which arise from the body-wall and are inserted into the intestine; in the head these are more numerous and completely fill up its anterior portion; the same is to be observed in the tail. Notwithstanding its apparent differences it has really a very close resemblance to the cœlom of other Platyhelminths.

The ventral mouth forms a three-rayed cleft, placed near the anterior end; it is extraordinarily extensile, on account, probably, of the great size of the protrusible proboscis; the pharynx forms a wide, richly ciliated cavity, and leads into the strong-walled crop; on either side lies a racemose "salivary" gland. The stomach only opens to admit the nutrient balls, formed in the crop, and is much less strongly ciliated than the parts in front of it. The rectum and anus are richly ciliated. The proboscis consists of a solid, not hollow, mass, and lies beneath the crop; it is angulated in the middle, and so appears to consist of two halves; the anterior portion is completely devoid of muscles, but in the hinder we find circular fibres which are distinctly striated, and below them a layer of less well developed longitudinal fibres. The author agrees with Hallez in thinking that the function of this organ is to brush the surface of plants to detach débris and diatoms, and that it does not, as in some Turbellaria, seize on living animals.

The eyes are well developed, and behind them, especially in

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 315–53 (2 pls.).

young transparent forms, there is a dark body, whence two trunks proceed forwards to the eyes, and two, which may be considered as the roots of the longitudinal trunks, pass backwards; elongated ciliated clefts, sometimes observable behind the second ciliated ring, probably correspond to the ciliated pits which have been noted in other species of this genus by Schmidt and Hallez.

With a high power cilia in action may be detected at various points of the body, and here and there we may see a plexus of clear, extremely fine canals, which, after some continued pressure on the cover-glass, may be made out over the whole body; the primary canals appear to be represented by wider ducts, which were most often detected in the hinder parts of the body, and near the ovary an orifice was seen on the ventral surface.

After describing the generative organs, and pointing out the lower organization of the male, and its shorter existence, which would seem to be in correlation with this, Korschelt passes to the developmental history; in the ova there were two polar globules; cleavage does not commence for some time after deposition, and is unequal; the smaller sphere then divides equally, and then a smaller sphere is separated off from the larger one. The large one then divides equally, and one of these breaks up again. Later on, the large sphere again divides, and the two are gradually overgrown by the smaller cells. The two endoblastic, as well as the ectoblastic cells present pseudopodial processes, and it is not for some time that cilia become developed. Later on, the eggs become very opaque.

As to its systematic position, the author finds that *Dinophilus* has most resemblance to the Turbellaria, but it is remarkable for the indications of segmentation, the arrangement of the cilia, the proctuchous enteron, the position of the proboscis behind the mouth, and the structure of the generative organs; a new family must at least, be formed for it.

Life-History of the Liver Fluke.*—Prof. A. P. Thomas undertook an investigation of this subject at the request of the late Professor Rolleston on behalf of the Royal Agricultural Society. The ravages made by the liver fluke have been very great (as many as 3,000,000 sheep being lost by it in this country in the year 1879–80), and the search for the intermediate host had previously been futile. Mr. Thomas thoroughly searched meadows for every species of mollusc likely to be an intermediary host, dissecting them without success, until at length he succeeded in finding in the small *Limnæus truncatulus*, a cylindrical Rédia, containing cercariæ. The cercaria is of tadpole shape, and has the peculiar habit of encysting itself directly it is brought into contact with any solid object, the material for encystation being exuded from some lateral masses in the body of the larva. For some time the inquiry was arrested because of the author's inability to find any more specimens of the *Limnæus*, even where they had abounded in the previous year. In July last, however, after floods, he found an ample supply. The snail in question is more truly amphibious than a water-snail, is very small—about

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 99–133 (2 pls.).

1-4th in. long—and wandering along the damp roots of grass, its presence may readily be overlooked.

The infection experiments proved that this mollusc was the sole intermediary host of the fluke. The fluke is very prolific, but so long as the ova remain in the liver they undergo no further change. In artificially hatching them, the embryo is seen to leave the egg by the sudden giving way of the operculum; and once in water the cilia with which the body of the embryo is covered come into action. The free-swimming embryo has a spindle shape and is provided with a double eye spot (two masses of pigment), and is very sensitive to light. If the embryo comes in contact with a *Limnæus truncatulus* it begins to bore into its shell, the head papilla becomes elongated and sharp, and by a sudden movement the boring is effected, and the body of the embryo passes into the snail. As soon as it gets into the snail the body contracts, its outer layer is cast off, and it degenerates into a sporocyst. By proliferation of cells lining the body-cavity and of cells in the body-walls, masses of germinal cells are formed from which the cercaria is developed. The sporocyst usually developes in the pulmonary cavities of the snail and the parasite gets into the liver, feeding on the liver cells. The cercaria is formed by the rounded germ-masses becoming elongated, one end being pinched off to form a tail. When the cercaria has escaped and become encysted, it remains quiescent until swallowed by the sheep; when, the cyst being dissolved, the embryo fluke finds its way into the liver ducts of the sheep. The real preventive of the disease is salt, a small quantity of which will not only kill the larvæ of the fluke, but the *Limnæus* also. The salt should be scattered over all land where the snail is believed to be present.

Ankylostoma and Dochmius.*—P. Mégnin, in examining a number of dogs attacked by the anemia which decimates large numbers annually in France, found that three apparently different species were always present. One in which the buccal armature has straight teeth answering to *Dochmius trigonocephalus* of Dujardin; another with hooked teeth like *Ankylostoma duodenale* of Dubini, which has previously only been found in man; and a third with hooked teeth, within the inner pair of which is a small tubercle like *Dochmius balsami* of Grassi = *D. tubæformis* of Dujardin.

As these three forms are constantly found living side by side in the same host and contributing to the same disease, the author considers that they represent one species in which the form of the teeth probably varies more or less with age.

New Floscullariæ.—Dr. C. T. Hudson announces the discovery by Mr. J. Hood of Dundee, of a very large and strange Floscule, new to science, which he names *F. Hoodii* after its discoverer.

It is no less than 1-10th of an inch in length, and is therefore by far the greatest of all the Rotifera, exceeding *F. trifolium* as much as that does *F. campanulata*. It has only three lobes, very short setæ, a very peculiar outline to its trochal disk, and, strange to say, two

* Bull. Soc. Zool. France, vii. (1882) pp. 282-9.

large conical hollow processes protruding one on each side of the anterior portion of the dorsal surface—perched right on the prominent dorsal lobe.

Dr. Hudson will figure and describe this new rotifer in the April number of this Journal, together with another new species, also discovered by Mr. Hood, *F. longicaudata;* the latter has its footstalk ending in a very long non-retractile pedicle, and forms also a peculiar tube.

Echinodermata.

'Challenger' Holothuroidea.*—The first part of H. Théel's Report on the 'Challenger' Holothuroidea is devoted to the new order Elasipoda, which name has with advantage been substituted for that of Elasmopoda, used in the Preliminary Report.† Seven years have scarcely elapsed since the discovery in the Kara Sea of the form for which this family was established, and now over fifty species are known. These species of Elasipods are true deep-water forms, and they may with all the more reason be said to characterize the abyssal fauna, as no single representative, as far as is at present known, has been found to exist at a depth less than 58 fathoms. Only one form, *Elpidia glacialis*, has been dredged at such an inconsiderable depth, and even this was dredged in the Arctic Ocean, where true abyssal forms are to be met with at comparatively shallow depths. This species, too, can exist at immense depths, one from Station 160 having been dredged at a depth of 2600 fathoms; the greatest depth at which any Holothuroid has hitherto been dredged being 2900 fathoms.

Among the more remarkable and distinguishing characteristics of this order, Herr Théel mentions the agreement in several important details—both in their internal anatomy and outer form—of the adult and larval states; an agreement more close than occurs in any previously known Holothuroid. He does not agree with Danielssen and Koren in placing the Elasipods low in the series of the Holothuroids; nay, in some respects he regards them as having attained to a higher development than all the other Echinoderms, because, among other facts, their bodies are distinctly bi-laterally symmetrical, with the dorsal and ventral surfaces distinct, and often with a cephalic region well marked. Only the ventral ambulacra are subservient to locomotion; these latter show a tendency to appear definite both as to place and number. The dorsal appendages are so modified as to perform functions different from the ventral ones. The report gives full details of all the new species.

Cœlenterata.

Nematophores of the Hydroida.‡—C. de Mereschkowsky has investigated the structure of the nematophores with regard to the

* Reports on the Scientific Results of the Voyage of H.M.S. 'Challenger' during the years 1873–6, vol. iv. (1882) 176 pp. and 46 pls. Cf. Nature, xxvii. (1882) pp. 74–5.

† See this Journal, iii. (1880) p. 268.

‡ Bull. Soc. Zool. France, vii. (1882) pp. 280–1.

general view that they consist not of cellular tissue, but of a structureless protoplasmic mass. He finds that these organs not only consist of cells, but that an ectoderm and endoderm and even a *membrana propria* are also present. The endoderm forms a solid axis, which at the base of the organ unites with the endoderm of the stem. The ectoderm, which covers it, is alone the seat of the amœboid movements, which take place chiefly at the superior extremity, where the endodermic axis is wanting. The cause of the movements is explained by the structure of the ectoderm. Its cells are immersed in a contractile protoplasmic mass, to whose contractility the movements are due.

Though these organs have no cavity they may be considered as degenerated polyps: (1) because their tissues are the same; (2) because each has a calyx; and (3) because the polyps can in certain circumstances transform themselves into a nematophore.

The author's observations were made on one species of *Plumularia*, two of *Antennularia*, and two of *Aglaophenia*. In the case of one of the latter he found that the tissues constantly contained parasitic algæ; the endoderm "yellow cells," and the ectoderm a green alga belonging to the Phycochromaceæ.

Green-cells of Hydra.*—In a contribution to the interesting question of symbiosis, O. Hamann points out that while Brandt believes that chlorophyll in animals is always associated with the presence of algæ, Geddes finds that supposed chlorophyll-containing animals may have (1) no chlorophyll, but green pigments—e. g. *Bonellia;* (2) forms with intrinsic chlorophyll—e. g. *Convoluta, Hydra, Spongilla;* and (3) "those vegetating by proxy" in which algæ live. The question that has to be answered is—How do the green-bodies enter the egg of *Hydra*, which for a certain time is free from them, and which itself arises from the ectoderm, in which green-cells are never found? The author put some *Hydræ* into a test-tube, and filled a quarter with water; when the animals were fully extended he added two drops of 1 per cent. solution of acetic acid; to this drops of 5 per cent. solution of chromic acid were added, until the water had a distinct yellow colour. The test-tube was then filled up with 70 per cent. alcohol; the solution drawn off, and alcohol gradually added until it was finally absolute. The animals were coloured by borax-carmine, then brought for a few minutes into absolute alcohol, cleared up with chloroform, and imbedded in paraffin. In sections the protoplasm of the cells is found to have a rosy colour, while the green-cells retain their original tint. If we direct our attention to the ovary, we see that, so soon as it begins to be formed, there commences an increase of the green-bodies at the corresponding point in the endoderm; and this is evident even to the naked eye, and from the exterior by the darker coloration of the animal at this point. At the time when, to use the words of Kleinenberg, the ovum has the form of a "butterfly with outspread wings," the green-cells are to be observed in it; they wander into the egg, from the endoderm, at the breaking-down of the supporting

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 457–64 (1 pl.).

lamella; the migration continues, and their number increases. The migration would seem to be passive, and dependent on the stream of nutrition which enters from the endoderm. Cultivation-experiments led to the conclusion that we have to do here, as also in *Spongilla* and *Paramœcium*, with the lowest unicellular algæ, which multiply by tetrad-formation; starch-granules as well as chlorophyll (and a nucleus) may be made out in their interior. Basing himself on these observations, the author feels justified in expressing a belief that whenever chlorophyll is found in the animal kingdom we have to do with green algæ, which live in the animals.

Prof. E. Ray Lankester * lodges a protest against the reception of Mr. Hamann's conclusions as reasonable, and repeats the views he has previously expressed † that there is no more and no less evidence for considering the green corpuscles of *Hydra viridis* as parasitic algæ than there is for taking a similar view with regard to the green corpuscles in the leaf of an ordinary green plant.

Development of the Ovum of Podocoryne carnea. ‡ — In this species, A. de Varenne has already shown that the ova do not originate in the interior of the Medusa, but in an endodermic cell of the cœnosarc of the hydra-polyp itself. This cell differentiates and then passes into a diverticulum, which, developing, becomes a Medusa. This Medusa detaches itself from the polyp, and swims free, carrying the ova, which occupy the walls of the manubrium and there arrive at maturity. He now describes the development of these ova, few observations only having hitherto been made on the species with free Medusæ, and as the result concludes that, in Hydroida which have a free Medusa, the ovum presents the same development as in the species which have sporosacs that remain always attached to the colony.

'Challenger' Deep-Sea Medusæ.§—The deep-sea Medusæ, which are described by Prof. E. Haeckel, form one of the smallest and least important groups of the rich and remarkable deep-sea fauna discovered during the voyage of the 'Challenger.' The number of species described does not exceed eighteen, of which half are Craspedotæ and half Acraspedæ. They were briefly diagnosed in the 'System der Medusen' in 1879, || but they are here described at great length and with a most splendid series of illustrations. The descriptive portion of the memoir is prefaced by a very elaborate sketch of the comparative morphology of the Medusæ, which is illustrated by many woodcuts.

It would seem by no means certain that all the eighteen species are constant inhabitants of the deep sea. The method of capture by the tow-net, by which such delicate and fragile organisms are brought

* Nature, xxvii. (1882) pp. 87–8.

† Quart. Journ. Micr. Sci., xxii. (1882) pp. 229–54.

‡ Comptes Rendus, xciv. (1882) pp. 892–4.

§ Reports on the Scientific Results of the Voyage of H.M.S. 'Challenger' during the years 1873–6, vol. iv. (1882) cv and 154 pp., 32 pls. and 15 figs. Cf. Nature, xxvii. (1882) p. 74.

|| See this Journal, iii. (1880) p. 272.

from great depths, is still imperfect, and it seems probable that the greater number brought up apparently from the greater depths really swim in shallow water, and are only taken in during the "hauling-in" of the net. But Prof. Haeckel considers that those Medusæ which have either adapted themselves by special modification of organization to a deep-sea habit of life, or which give evidence by their primitive structure of a remote phylogenetic origin, may with great probability be regarded as permanent and characteristic inhabitants of the depths of the sea; and as such he regards fourteen out of the eighteen described. With regard to the illustrations, the author states:—"It is of course impossible, from the imperfect state of preservation of the spirit specimens, to expect that they should be absolutely true to nature. I rather considered it my duty here, as in those figures in my 'System der Medusen,' which were drawn from spirit specimens, to take advantage of my knowledge of the forms of the living Medusæ to reconstruct the most probable approximate image of the living forms."

'Challenger' Corals.*—Mr. H. N. Moseley describes the Hydroid, Alcyonarian, and Madreporian Corals obtained by the 'Challenger.' The chief results embodied in the first and second parts have already been published in the author's communications on the Hydrocorallinæ and Helioporidæ, though they have been recast, and contain both additions and alterations; but the third part comes as a fresh work, the preliminary catalogue of the deep-sea Madrepores having been necessarily very imperfect. We have now extended descriptions and figures of the entire series of species dredged during the voyage with thirty-three species described for the first time.

These deep-sea Madrepores would appear to be very widely distributed, some, as for example *Bathyactis symmetrica*, having a world-wide range. At present the only genera which seem restricted in range are *Stephanophyltia* and *Stephanotrochus*, which have as yet only been obtained from the seas of the Malay Archipelago, and in comparatively shallow water, and the genus *Leptopenus*, which has been dredged throughout all the great oceans, but only south of the equator. The wide range of species in depth has now become a well-known fact, though none the less interesting for that, the world-distributed species above-mentioned ranging in depth from 70 to 2900 fathoms. The occurrence of the genera as fossils in Secondary and Tertiary deposits is also not without interest; but the deep-sea forms are not to be regarded as of greater geological antiquity than those found in shallow water.

Morphology of the Coral-Skeleton.†—G. v. Koch, after a brief review of the opinions of previous writers, reminds us that the separate polyp is always a more or less cylindrical tube, with a mouth at one end; thence an internal tube passes into the cavity. Around the

* Reports on the Scientific Results of the Voyage of H.M.S. 'Challenger' during the years 1873–6, vol. ii. (1881) 248 pp. and 32 pls. Cf. Nature, xxvii. (1882) pp. 73–4.

† Biol. Centralbl., ii. (1882) pp. 583–93.

mouth are the tentacles. The body-wall consists of ectoderm, mesoderm, and endoderm. The first and last are composed of epithelial cells, not separated by any intermediate substance. The mesoderm, on the contrary, always consists of a continuous plate of hyaline substance, in which cells and groups of cells are very irregularly deposited. From it there proceed to the digestive tube a number of radially arranged, lamelliform processes, which are invested on either side by endoderm, and with a varying amount of muscular fibres. The number of these partitions is often constant for a whole group of corals.

The skeleton, under which term all the hard parts may be included, consists either of numerous small particles, separated by soft substances, or of larger, connected pieces, which may belong to a single animal, or to a whole colony. The relative proportion of organic to inorganic substances varies greatly, and we have all stages between skeletons in which there is but a minimum of inorganic substances (horny skeletons), and those in which the inorganic materials are superabundant (calcareous skeletons). The simplest forms of the latter are the isolated and often microscopic spicules, which are found in most Alcyonaria and in *Polythoa*. They are always found in the mesoderm, rarely project into the ectoderm, and never into the endoderm. Occasionally simple, they are often very complicated in structure. Microscopic examination, after decalcification, shows that they are formed of concentric layers of more or less horny intermediate substance, and of calcareous crystals; the layers of the former are very thin, and can only be found in their natural positions with the greatest care. In *Gorgonia* or *Clavularia* (the only two forms which have as yet been examined with regard to this point), it has been found that the spicules always arise in cells, which are always primitively ectodermal, and afterwards pass more or less deeply into the mesoderm. The spicules are at first smooth, often triangular, needles, which are at first perhaps hollow, and only take on their definite form by the gradual deposition of new layers. The nucleus of the mother-cell is long persistent, but the protoplasm becomes a very thin layer.

The larger calcareous masses, which are found in the axes of the colonies of such forms as *Corallium* or *Melithæa*, arise from separate spicules, which become connected together by the deposition of fresh calcareous substance; and that, without the spicules themselves becoming altered in character. With this may be associated the arrangements seen in *Tubipora*, where the separate spicules may be seen gradually passing into a connected lamella.

We come next to the Madreporaria, and here, if we take a separate polyp, we may distinguish a sclerobase from the septa, which are connected with it, and may be regarded as direct continuations of it; thirdly, there is a theca, which holds the same relation to the sclerobase and the body-wall, as do the septa, with the peripheral ends of which last it is fused; lastly, there is the exotheca, which is very frequently wanting, and which is nothing more than a continuation of the sclerobase. This skeleton consists of crystalline spheroids, which are either directly connected with one another by means of their

peripheral ends, or by small isolated crystals. According as the skeletal pieces are formed by solid masses, or by numerous lamellæ, with intermediate spaces, we have the Madreporaria aporosa, or porifera. The development of the skeleton has only been worked out in *Astroides calycularis*, and there the ectoderm of the pedal disk gives rise to a thin calcareous plate—the sclerobase of the future polypary. The crystalline corpuscles, which make it up, appear to be secreted by the ectodermal cells, and they soon fuse with one another and take on a polyhedral form.

The porcellanous membranes, which are found in such forms as *Calliactis*, probably belong to the skeletal series, and may be regarded as the analogue of the first rudiment of the skeleton. The horny skeletons are either connected secretions of an epithelium, or investments, varying in thickness, of the calcareous corpuscles. The former, when simplest, are thin lamellæ which present a striated structure, and are developed from the ectoderm of the foot-disk (some Actiniæ). In the Cornularidæ they are better developed, and form a more or less firm test, into which the whole polyp can be retracted. They are made up of thin lamellæ, which are not separated by any interspaces, and are only with difficulty separated from one another. In the Antipathidæ and Gorgonidæ—e. g. *Gerardia*—the ectoderm secretes a horny lamella, which differs a good deal in the different families and genera, as to the extent to which inorganic substances enter into its composition. The study of *Gorgonia* shows that the simple polyps first secrete at their distal end a thin horny lamella. The growth of the axial skeleton is *pari passu* with the formation of polyps, till at last we have a colony of a number of separate animals, which appear to invest the axial skeleton, although this last is a product of the primitive ectoderm. The axis of the Pennatulidæ presents a considerable resemblance to that of the Gorgonidæ, and in them, too, there is an axial epithelium.

The horny sheaths of the spicules must be regarded as products of the cells, and not as hardenings of the intermediate substance; this is demonstrated by their relations, both in early and late life, to the protoplasm of the cells. These sheaths often secondarily fuse with one another and then form pretty strong skeletal parts, as in the axes of *Sclerogorgia*, &c.

Protozoa.

Suctociliata, a New Group of Infusoria, intermediate between the Ciliata and the Acinetina.*—Well-marked characters separate the ciliated Infusoria from the Acinetina; and up to recently no intermediate form has been indicated as forming the passage between the two groups. In the Bay of Naples, however, Dr. C. de Mereschkowsky met with an intermediate form, presenting at the same time the cilia of the ciliated Infusoria and the suckers of the Acinetina.

At first glance it might be taken for a Halterine, to which it presents some resemblances. In size it does not exceed a small *Halteria;* its body, which is rounded and somewhat pyriform, ter-

* Comptes Rendus, xcv. (1882) pp. 1232–5.

minates anteriorly in a slightly developed conical neck, at the extremity of which there is an aperture. The body is clothed with a thick cuticular membrane, and this presents spirally arranged longitudinal folds. The neck, covered with a thin cuticle, is alone contractile ; at the will of the animal it can invaginate itself in the interior. At the base of the neck there is a collar of long cilia, by means of which the animal can execute two kinds of movements ; one slow, as if the animal were creeping over various objects ; the others are sudden rapid leaps. The cilia are about as long as the body, stout, rigid, and arranged in three circles placed one above the other ; each circle contains seven or eight cilia, so that the entire collar consists of from twenty-one to twenty-four. A nucleus and a contractile vacuole are present.

The most interesting point in the organization of this animal is the constant presence of four suckers, arranged symmetrically upon the margin of the orifice of the neck. They are very short, not so long as the neck ; and in structure are the same as the suckers of the Acinetina. When the neck becomes invaginated, the suckers are likewise carried into the interior, and cannot then be observed. It is this position that the animal usually presents, and it is then easily mistaken for a ciliated Infusorian. Sometimes the animal fixes itself, by means of its suckers, to various objects ; or it may creep slowly by the aid of its cilia, with the mouth open and the suckers directed forward.

This Infusorian was first found by Cohn, who gave a very superficial description of it under the name of *Acarella siro*. The essential character of the presence of the four suckers, as well as several other characters, escaped him ; and this led him to place it among the Ciliata. As, however, by some of its characters it is a ciliated Infusorian, and by others an Acinetine, it is necessary to form for it, at least, a distinct family, which the author proposes to name Suctociliata. This family may be arbitrarily arranged in either of the orders as an intermediate form ; or, if it be preferred, as a new order Suctociliata.

It remains to be learned whether the Suctociliata are not ancient primitive forms which may have given origin, on the one hand, to the Ciliata, by the disappearance of the suckers, and, on the other, to the Acinetina, by the suppression of the vibratile cilia ; or should we not rather regard *Acarella siro* as a Ciliate which has acquired suckers without having any genealogical relations with the Acinetina ? or, lastly, as an Acinetine which may have retained its embryonic cilia until its adult age ? We cannot choose any one of these three suppositions as being the most probable, all three of them having considerations in their favour. The developmental history of the Infusorian, which is very difficult to study on account of its rapid movements, can alone decide the matter with certainty. The last of the suppositions, however, seems the least probable.

M. E. Maupas adversely criticizes * Mereschkowsky's views, pointing out that Stein's *Actinobolus varians* is a better intermediate form, and that the author is in error in saying that the Acinetidæ have vibratile cilia only in their embryonic state, as some *Podophryæ*

* Comptes Rendus, xcv. (1882) pp. 1381-4.

and all the *Spherophryæ* are able to resume their cilia and become free. The form described is moreover very common, and has been previously published by Claparède and Lachmann, Fresenius, and Quennersted, as well as by Cohn. He also considers that the assimilation of the "suckers" to those of the Acinetidæ is a purely gratuitous assumption not resting on any positive observation, the so-called suckers never having been observed to act as such but solely as fixing organs. Further the vibratile appendages of the Acinetidæ are always simple vibratile cilia, whilst in *Acarella* they are compound or true cirri, and represent therefore the higher state of development. M. Maupas adheres to his view * that the ancestral affinities of the Acinetidæ are with the Heliozoa rather than with the Ciliata.

Dr. Mereschkowsky replies † to this criticism, maintaining the correctness of his original paper on all points.

New Infusorian belonging to the Genus Pyxicola.‡—Professor J. Leidy describes an infusorian, a species of *Pyxicola*, which appeared to be different from those previously described. It is of frequent occurrence, attached to the tubes of *Plumatella*, *Urnatella*, and *Cordylophora*, on stones. In shape it resembles *Pyxicola pusilla* and *P. affinis*, fresh-water forms of England, but is annulate as in *P. socialis*, a salt-water form. It presents the following characters:—

Pyxicola annulata. Lorica urceolate, slightly curved, inflated towards the middle, tapering below, cylindrical and feebly contracted at the neck, and with the aperture oblique and circular, variably annulate, mostly at the neck, often at the middle; colour chestnut-brown, but colourless when young; pedicle short, always colourless. The contained animalcule is of the usual shape, with an attached operculum, which is of the same colour as the lorica, and is protruded beyond this when the animal is fully extended. Length of lorica, 0·52 to 0·792 mm.; breadth, 0·02 to 0·0264 mm.; length of pedicle, ·004 to ·008 mm.

Systematic Position of Amphidinium.§—R. S. Bergh supplements his previous observations on the Cilio-flagellata by a note, in which he places *Amphidinium* with the Gymnodinidæ, and not with the Dinophyidæ, as he originally proposed.

Evolution of the Peridinina.‖—M. Pouchet brings forward some observations which, he thinks, reveal a new order of phenomena in the genesis of the Peridinians. The different varieties of *Ceratium furca* and *C. tripos* always occurred, as usual, isolated, of equal size, and with no traces of any genesic operations, until, on October 9th, a single cast of the net furnished no fewer than three forms of *Ceratia*, namely, *C. tripos* and its var. *megaceros*, and *C. furca*, arranged in chains of two, three, and up to eight individuals joined end to end. The boat was four or five miles off the shore; and the depth was 80–100 metres. These curious chains are probably formed at the bottom. The mode of union of the individuals is as follows:—The

* Cf. this Journal, ii. (1882) p. 639.
† Comptes Rendus, xcvi. (1883) pp. 276–9.
‡ Proc. Acad. Nat. Sci. Philad., 1882, pp. 252–3 (2 figs. of a plate to follow).
§ Zool. Anzeig., v. (1882) pp. 693–5.
‖ Comptes Rendus, xcv. (1882) pp. 794–6.

aboral or posterior horn (anterior of Stein) is inserted by a truncated extremity at the left-hand margin of the ventral depression of the succeeding individual, just at the point of termination of the transverse furrow. The individuals in chains were motionless, with neither flagellum nor cilia.

This arrangement, and especially the apparent anterior evolution, would seem to approximate the Ceratina to the Diatoms and Desmids, while other peculiarities appear to indicate a relationship between these creatures and the *Noctilucæ* closer than that accepted by Stein, who places his groups Scytomonadina between the latter and the Peridinina. Some large *Ceratia* allied to *C. divergens*, and about 0·160 mm. in length, show remarkable characters. The protoplasm, protected by the carapace, is slightly rose-coloured, with a large spherical nucleus and some drops of oily appearance and of a bright chamois-colour; the creature is asymmetrical, and as if twisted upon its axis; the extremity (truncated as usual) of the aboral horn appears excavated into a groove; and on the right-hand side of the ventral depression there is a strong projection in the form of a lamp (Claparède and Lachmann, Stein). All these characters occur in a striking manner in the *Noctilucæ*, especially at the moment of an ascent of these creatures to the surface of the sea:—flagellum (Huxley, Robin, Stein); envelope hyaline, resistant, sometimes distinctly reticulated; rosy coloration of the protoplasm, with a nucleus and oily drops of the same dimensions and the same colour; well-marked asymmetry in the basal piece of the tentacle and lip projecting on the right side (Huxley, Robin).

The analogy becomes still more manifest if, instead of spherical floating *Noctilucæ*, we take the forms which have already puzzled Busch, and which are not found at the surface, but at the bottom of the vessels in which the products of fishing have been collected. In these the internal framework (formed, not by a style or bacillus, but by two kinds of glumes) produces by its extremities, three processes or horns—two in front, pointed, and more or less recurved, and a third aboral, excavated into a groove. The size of these tricuspid *Noctilucæ* (0·190 mm.) scarcely exceeds that of the large *Ceratia* from which they seem to have issued, to become subsequently swelled up by accumulation of water in lacunæ originally independent of their protoplasm. In these *Noctilucæ* there is often a prominent curved projection, which seems to mark the contour of the ciliary circlet. Of the formation of the tentacle the author can say nothing, and he remarks that the suggested relationship is purely hypothetical.

New Thuricola.*—Dr. A. C. Stokes describes a new species of Kent's recently established genus *Thuricola* (*T. innixa*) found on the leaflets of *Ceratophyllum*. The lorica is sessile, transparent, sub-cylindrical, four to five times as long as broad, truncate, and somewhat tapering posteriorly, bearing at some distance from the orifice an internal valve-like appendage as in *T.* (*Vaginicola*) *valvata*, and an opposite, rigidly attached, but flexible, membranous organ projecting arcuately

* Amer. Mon. Micr. Journ., iii. (1882) pp. 182–3 (1 fig.).

inwards, and acting as a support to the edge of the descending valve, the wall of the lorica being dilated laterally immediately behind this, in optical section bristle-like, valve-rest; body pedicellate, hyaline, projecting when extended one-third its entire length beyond the orifice of the lorica; pulsating vesicle anterior, contracting once in fifteen seconds.

Flagellata.*—J. Künstler's extended article on this subject appears in the first part of the French Zoological Society's Bulletin. This has only just been distributed to Societies exchanging, although purchasers have long been in possession of it. It is much to be wished that some of the foreign Societies could be induced to forward their publications (as the Royal Microscopical Society does) immediately on issue, instead of one, two, or even three years after date, as is now often the case. The present article has already been anticipated, and a brief extract of it appeared in Vol. II. (1882) p. 62. We may add here that it comprises the following parts:—

(1) Introduction and historical view (in which the various systems of classification are discussed). (2 and 3) Descriptive part (which deals with the exterior, flagella, integuments, physiological considerations, digestive apparatus, general cavity, vestibulary tube, contractile vesicle, oculiform point, reproductive apparatus, and development). (4) General considerations (cell, and protoplasmic spherule). (5) Systematic considerations. (6) Bibliography.

A "further contribution" on the same subject † was abstracted at p. 518 of Vol. II. (1882).‡

Prof. O. Bütschli § ridicules the author's views of the organization of the Flagellata, and his description of the complicated structures which he discovered in them in the way of stomach, intestine, uterus, &c., and in particular depreciates the value of his observations by pointing out that the new genus *Künckelia gyrans* which he founded, and of which he gives elaborate woodcuts, is, in fact, neither more nor less than a *Cercaria!*

Microsporidiæ or Psorospermiæ of Articulates.‖—E. G. Balbiani, as the result of investigations on their mode of reproduction, proposes to designate as "Microsporidia" or Psorospermiæ of the Articulates the "corpuscles" of the silk-worms which he considers to be nothing else than the spores of an organism having affinities with those for which Leuckart proposed the name of Sporozoa, which includes already (1) the Gregarinidæ, (2) the oviform Psorospermiæ or Coccidiæ, (3) the tubuliform Psorospermiæ or Sarcosporidiæ, and (4) the Psorospermiæ of Fishes or Myxosporidiæ.

The microsporidia of *Attacus Pernyi* is formed when young of a

* Bull. Soc. Zool. France, vii. (1882) pp. 1–112 (3 pls.).

† Ibid., pp. 230–6 (7 figs.).

‡ In his first paper the author throughout calls the species to which his description refers, *Cryptomonas ovata* Ehrbg., though at the same time he expresses his opinion that his species was in reality a new one, *Heteromitus olivaceus*. In the second paper the latter name only is used.

§ Zool. Anzeig., v. (1882) pp. 679–81.

‖ Comptes Rendus, xcv. (1882) pp. 1168–71.

small mass of homogeneous plasma, which grows, and clear nuclei appear in the interior, each of which is surrounded by a layer of plasma; these are the young spores. Their substance condenses, they take an oval form, and the nucleus ceases to be visible. The ripe spores are identical in size and appearance with the "corpuscles" developed in silk-worms attacked with pelvine. They resemble the spores of some *Bacilli*, *B. amylobacter* for instance, and their mode of germination is nearly the same, that is, it is effected by the perforation of the spore at one of its extremities and the exit of the interior plasma, but instead of taking the form of a rod, as in the *Bacilli*, it escapes as a small amœboid mass, which reproduces the vegetative phase of the parasite.

Another species of microsporidia was found in an Orthoptera, *Platycleis grisea*, and like the former, in the epithelial cells of the stomach.

Development of Gregarinæ and Coccidia.*—Gregarines of the genus *Stylorhynchus* are found by Schneider to produce rosary-spores; the contents of these spores consist at first of granular protoplasm with large spherical nucleus, but subsequently become converted, in each case, into eight falciform bodies, each with a separate nucleus. If to the mature spores is added, under the Microscope, some fluid from the intestine of a *Blaps*, they open spontaneously along their convex border, and the *sporozoites* issue by the movements of their anterior extremity. If observed for some time, they seem to endeavour to penetrate the subjacent surface, which would under normal conditions be an epithelium. Observations of the tissues of the *Blaps* seem to Schneider to confirm this supposition; for on macerating the intestine, its cells are found each to contain, by the side of its nucleus, a body identical with a *Coccidium*, viz. provided with a nucleus of its own and occurring in all conditions from the earliest stage up to that at which it issues into the alimentary tract by bursting the cell which incloses it. In order to assume the *Monocystis*-form, it has now to divide into segments. The original nurse-cell persists as a cap on the head of the *Stylorhynchus*.

Coccidia.—Spores of the genus *Klossia* develope as follows:—Directly after the formation of the cyst, the nucleus consists of a wall, a nuclear liquid, and a freely suspended nucleolus, consisting of an external, dense, and an internal, more fluid, layer; there is no reticulum. In the following stages the nucleus buds out globules one by one—to the number of 30 in one instance observed—which form a bunch upon it. These bodies probably grow at the expense of the nuclear liquid; the nucleolus diminishes in proportion to their growth: they seem to undergo fission, for some are found constricted across the middle and inflated at their extremities. In the next stage the wall of the nucleus disappears, and the globules are set at liberty among the granular contents of the cyst. The globules reach the periphery, apparently by automatic movements; they subdivide frequently in the cortical zone of the cyst, and during the process

* Comptes Rendus, xcv. (1882) pp. 47–8.

present the form of long ribbons expanded at the ends and very attenuated in the middle; their division results ultimately in the production of an enormous number of small nuclei, distributed over the external layer of the cyst at close and regular intervals. Soon each of these nuclei recedes from the cyst, causing a projection from its surface and drawing out with it a conical protoplasmic process; this, inclosing the nucleus, becomes detached from the cyst by constriction of its base, and constitutes a spore.

Gregarinidæ of Annelids.*—Professor J. Leidy describes and figures four new species: *Monocystis mitis* in *Distichopus* (remarkable from its frequently containing a variable number of curved elliptical bodies—spores ?), *Anoplophrya modesta* and *A. funiculus* in the body-cavity of *Enchytræus*, and *A. melo* in that of a species of *Lumbricus*.

Intestinal Parasites of the Oyster.†—In a further communication,‡ A. Certes describes the methods by which he obtained the contents of the stomach of the oyster. A narrow tube is introduced into the mouth of the animal, and the contents drawn out by suction; in this way the misleading presence of hepatic and generative cells is completely avoided. Although the contents do not redden litmus paper, the calcareous tests of Foraminifera are dissolved in the stomach. The use of dahlia-violet, which colours living specimens and slows their movements, has resulted in the demonstration of the presence of a small oval nucleus.

Attention is directed to the use of methyline blue, which the author uses either to colour organisms already killed and fixed by osmic acid, &c., or as a reagent for living protoplasm. In the latter case, a drop of the alcoholic solution is placed on a slip, and allowed almost to evaporate; a drop of the liquid to be examined is then added, and as soon as it begins to be coloured the solution is tipped over, and the presence of crystals thereby avoided.

By this means it is not necessary to add distilled water or alcohol, which would immediately kill the organisms.

There are some observations on *Enchelyodon*, but the author is not yet satisfied as to the family to which it belongs; and on *Prorocentrum micans*, in which a nucleus has been detected; no observations could be made on its supposed phosphorescence.

Perception of Light and Colour by the lowest Organisms.§—The instances in which these faculties are exhibited in the lowest forms, even extending to some true plants, are very numerous, but hitherto have met with little explanation. T. W. Engelmann has now turned his attention to the subject. The facts which he has discovered, or with which he is acquainted, appear to him to point to three principal modes by which light is able to affect these organisms, viz.:—

* Proc. Acad. Nat. Sci. Philad., 1882, pp. 146–8 (4 figs.).
† Bull. Soc. Zool. France, vii. (1882) 7 pp. (1 pl.).
‡ See this Journal, ii. (1882) p. 804.
§ Pflüger's Arch. Physiol., xxix. (1882) pp. 387–400.

1. Directly, by modification of the interchange of gases, without apparent addition of a sensation.

2. By modification of the sensation of necessity for breathing, owing to modification of the interchange of gases.

3. By setting up a specific process, which probably answers to our sensation of light.

Of these, the first may occur either alone or in combination with the second; simultaneous occurrence of the first and third may possibly take place.

1. *Navicula* is taken as type of the first method, and most mobile Diatomaceæ and Oscillarineæ belong to the same class. *Pinnularia* was also examined. Movement is here intimately connected with the presence of free oxygen, which, if not present, can be produced by these organisms in the light. It is for this reason that light is able to revive the movements when they have ceased through want of oxygen in the darkness, whereas when sufficient oxygen is present already in the water, the light exercises no distinct influence on the energy of the movements. After movements have ceased owing to want of light, they may be made to recommence by placing the diatom in the red part of the spectrum. It is found that red between the lines B and C promotes movements the most actively, while ultra-red and ultra-violet are quite ineffective. The relation to the colours of the spectrum, together with the amount of light required (which is constant), agree with those indicated by the bacterium test. Taking that of the red between B and C as the maximum, the percentage of energy developed by the other colours is:—

Extreme red (*a*)	22·7
Green (E ½ *b*)	14·1
Extreme blue (F)	6·9
Violet (G)	1·2

2. *Paramœcium bursaria*.—When the proportion of oxygen is normal, or somewhat greater than the normal amount, the Infusorian is usually very quiet; if, however, it sinks ever so little below this degree, the animal becomes restless, and makes for places in which there is more oxygen (e. g. edge of cover-glass); in good light, but under otherwise similar conditions, the specimens distribute themselves equally throughout the drop. Active swimming is the consequence of serious diminution of the oxygen; if strong light is then applied for some minutes, the *Paramœcium* courses rapidly about, and if insufficient supplies of oxygen are added from without, it shows itself very sensitive to alterations in the illumination in the spectrum; it prefers red of between the lines B and C. The obvious explanation of this and other details is that, in default of oxygen from without, the chlorophyll contained in the mesoplasm acts as it does in plants—viz. excretes oxygen; it exhibits in its action the same dependence on amount and quality of light as do the movements of the animals. The energy of the excretion is as follows for different parts of the spectrum, taking the red between B and C as 100:—

	In sunlight.		In gaslight.
Outer red (*a*) ..	9·7	..	24·7
„ yellow (D) ..	35·2	..	23·3
„ green (E ½ *b*)	14·6	..	6·2
„ blue (F) ..	25·5	..	5·3
„ violet (G) ..	8·2	..	0·8

High tension of oxygen reacts strongly on the movements, for the animals then tend to swim straight or in wide curves away from the point at which oxygen is present in abundance. Strong illumination applied suddenly at this time causes violent movements, and the *Paramœcium* often darts into the darkness, exhibiting the phenomenon of photophobia. Thus this animal is very highly sensitive to differences in the tension of oxygen.

3. *Euglena viridis* is taken as the third type. It appears that in both it, *Colacium*, *Trachelomonas*, and some allied forms, the tension of oxygen has little to do with the movements. In darkness and great dearth of oxygen gradual dissolution produces, naturally, an increasingly feeble sensitiveness to light; but even under high tension of oxygen the reaction with light appears to be always less than usual. When the drop of water is partially illuminated the *Euglenæ* gradually assemble in the lighted area, and usually remain there; if a shadow is thrown upon the anterior chlorophyll-less portion of the body the animal turns and behaves as if wholly in darkness. This is not due to the eye-spot which is placed here, as the reaction is effected when the darkness first reaches the protoplasm outside it. This sensitiveness of the anterior end of the body is generally distributed amongst animals, and occurs in *Paramœcium bursaria*, in spite of the greater amount of chlorophyll contained in the posterior part. The difference between *Paramœcium* and *Euglenæ* in relation to light is more distinctly shown by the use of the spectroscope; whereas the former prefers the slightly refrangible red rays, the latter prefers the blue end of the spectrum, whether gaslight or daylight is employed. The following is a good average sample of the way in which *Euglenæ* distribute themselves over the spectrum, and should be compared with the tables given above:—

Between A and C 3-4ths D (red to orange) ..	2	individuals.
„ C 3-4ths D and D 5-6ths E (orange to green)	0	„
„ D 5-6ths E and *b* 5-6ths F (green) ..	16	„
„ *b* 5-6ths F and F 4-7ths G (green to blue)	100	„
„ F 4-7ths G and G (blue to indigo) ..	24	„
„ G and G ½ H (indigo to violet)	3	„

In the spectrum the individuals swim in all directions, as in complete darkness. The sensitiveness to minute differences in the quality of the light is decidedly greater in the red, yellow, and green than in the blue. Engelmann has not as yet succeeded in finding blind or colour-blind *Euglenæ*, but individuals from different localities and in different stages of development often show important variations in their sensitiveness to light.

BOTANY.

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

Development of the Pollen of Orchideæ.*—L. Guignard has investigated the structure and mode of development of the pollen in Orchideæ, especially in the Ophrydeæ and Neottieæ. The primordial mother-cells of the pollen are formed from a hypodermal layer, each of whose cells divides into an outer and an inner cell, the latter becoming the pollen mother-cells. They constitute, therefore, at first a simple layer, and are distinguished from the other cells by their denser cell-contents. Each of these cells further divides in different directions, and developes into one of the "massulæ," the peripheral cell-walls of which are much thicker than the inner walls. The outer hypodermal layer also undergoes numerous divisions, dividing into an inner layer, the "tapete," and an outer layer the walls of which are strongly thickened, but do not, as in most other plants, become fibrous.

The further development of the mother-cells of the pollen more closely resembles in some respects that of dicotyledons than of other monocotyledons. The cells do not divide completely, but only their nuclei, not even a cell-plate being formed. The two nuclei again divide into four, which are arranged either in one plane or in a tetrahedron. The true membrane of the pollen-grains is formed nearly simultaneous, on the side towards the mother-cell-wall, and in the equatorial plane of the nuclear spindle. It often has a granular extine composed of two layers, the outer one of which, however, occurs only at the periphery of the tetrahedron. During its formation the mother-cell-wall becomes absorbed.

The author confirms Strasburger's and Elfving's account of the part played by the two nuclei in the act of impregnation. The process can be very well followed out with the assistance of colouring reagents, either in the process of fertilization itself, or by making the pollen-grains germinate in a 2 per cent. solution of sugar. The tetrahedra of *Neottia ovata* and *nidus-avis* are specially favourable for observation. Colouring with hæmatoxylin immediately after the pollen-tube has burst through the extine shows the larger nucleus occupying the swollen extremity; at some distance is the elongated granular vegetative nucleus. At the moment of impregnation this latter has almost entirely disappeared, while the larger nucleus becomes resolved into an amorphous substance which is still coloured by hæmatoxylin, and passes through the thin wall at the extremity of the pollen-tube. Under artificial conditions the extremity of the tube may often be seen to be perforated. The protoplasm of the pollen-grain has in the meantime entered the tube along with the nuclei, and becomes aggregated into balls.

Formation of the Pollen-grains in Gymnosperms.†—L. Juranyi has investigated the details of the mode of formation of the pollen in

* Ann. Sci. Nat. (Bot.), xiv. (1882) pp. 26-45 (1 pl.).

† Bot. Ztg., xl. (1882) pp. 814-8, 835-44.

Ceratozamia longifolia and *Zamia furfuracea* among Cycadeæ, and in *Pinus Laricio*, *sylvestris*, *Pumilio*, and *Strobus*, and *Abies excelsa* among Coniferæ.

The pollen-grains of Cycadeæ divide either successively or simultaneously; both modes may occur in mother-cells from the same anther. In the case of successive division, after the new nuclei have been formed with their uniting-threads, and the cell-plate has already become visible in these latter, corresponding to the plane of division, the cellulose-ring makes its appearance as an externally projecting cushion on the mother-cell. The starch-grains are grouped round the new nuclei, especially on the side nearest the cell-plate. The cellulose-ring projects at a later period into the cell, and meets the cell-plate formed by thickening of the cell-wall. This ring had been previously described by Juranyi and others as the young division-wall. The stretched uniting-threads are by it constricted; and it is possible that the cell-plate takes part in the formation of this ring. When it has attained a certain width, the new division is suddenly formed at once from the cell-plate, and the division is complete. The same process is then repeated in the daughter-cells, except that the cellulose-ring does not attain so great a breadth and thickness. In opposition to Treub, the author states that the division-wall of the daughter-cells is formed entirely from the cell-plate.

In the simultaneous mode of division the process is the same up to the formation of the first cell-plate. The cellulose-ring is usually smaller than in the first case; when it has attained its full width, the cell-plate is absorbed. The uniting-threads become afterwards invisible, from the starch-grains becoming forced towards the first division-plane, so that the space between the two nuclear spindles is filled with them. They begin to disappear as soon as the halves of the nuclear plate reach the pole of the nuclear spindle, a few only remaining visible near the nuclei, the whole cell-cavity being occupied by uniting-threads. The cell-plates are now formed, partly between the nuclei, partly in the position of the first plate which has disappeared, and the division is completed by the appearance of a thin septum. After the thickening of the cell-walls, especially the septa, the tetrads remain in this condition for a considerable time.

The form of the pollen-grains and the mode of formation of their membrane agree with those of some angiosperms (e. g. *Allium odorum*, *senescens*, and *nutans*, and *Tradescantia pilosa*, &c.), and the author's observations agree in essential points with those of Treub. The inner layer of the wall of the mother-cell is always coloured by methyl-green. In *Ceratozamia longifolia* the mother-cells have not the capacity of swelling so strongly as in *Zamia*, and their membranes consist of only two layers; the inner one only, which becomes the wall of the pollen-cell, is coloured by methyl-green. After this layer has become detached from the outer layer of the cell-wall, an opening appears in the latter, through which the young pollen-grains escape. The membrane of the pollen-cell is therefore, as in other plants, the innermost layer of the wall of the mother-cell.

The process is the same in Coniferæ, except that the projections

of cellulose are not nearly so strongly developed. The pollen-grains are unicellular till shortly before pollination. As this time approaches the starch-grains disappear. The single small cell which occurs in *Taxus* is then formed by division, constituting the unicellular prothallium. When the prothallium is multicellular its cells are produced by successive divisions of the large cell behind those previously in existence; but this process is more readily seen in the Cycadeæ than in the Coniferæ. The author traces a close analogy between the formation of the prothallium of Gymnosperms and that of the male prothallium of Vascular Cryptogams, especially of *Isoëtes*.

The pigments used by the author are methyl-green, anilin-red, eosin, alum-carmine, and picric acid.

Conduction of Pollen-tubes.*—Holzner ascribes to the outer integument of the ovule in *Hordeum* and *Bromus* an important function in assisting the pollen-tubes to reach the embryo-sac. The cells of this integument are of the same nature and have the same contents as those of the conducting tissue of the style, with which they are in direct connection.

Female Flowers of Coniferæ.†—Professor Eichler's paper on this subject has induced L. Celakovsky to reinvestigate it. After reviewing the different theories and explanations enunciated since Robert Brown's time, he dwells emphatically on the great importance of the study of the *anamorphoses* (as he calls those monstrosities which are the result of retrograde metamorphosis, in contradistinction to mere pathological changes) and of the teaching they convey. He comes to the conclusion that these are a much safer guide than the microscopic study of the genesis of the organs, which has often misled those who too implicitly relied on its teachings. Investigating the anamorphoses of the Norway spruce, he finds the two lateral carpellary leaves distinctly indicated, and more or less separated and developed. In a more mature state an anterior and then a posterior bract make their appearance; these, Professor Eichler had taken for a third and fourth lobe of his ligula (normally the posterior bract is the third and the anterior the fourth in order). Celakovsky comes to the conclusion that, at least in Abietineæ, Eichler's theory (that the carpellary scale is a mere emergence or ligule of the bract) is quite wrong, and that Mohl's view of 1871 that the carpellary scale of these plants consists of the two connate lowest leaves of an axillary, otherwise undeveloped, bud connate at their upper edge and producing the ovules on their back, is amply vindicated by all known morphological facts, and is antagonistic to none of them.

He further concedes that the same explanation may possibly be the true one for all conifers, and that all morphologists who have treated this question thus far, have, whatever their views, assumed a conformity in this respect in all the tribes of conifers, and a complete homology of their female organs. But he thinks that this is not

* SB. Versammlung deutscher Naturforscher u. Aerzte in Eisenach, Sept. 19, 1882. See Bot. Centralbl., xii. (1882) p. 107.

† Abh. K. Böhm. Ges. Wiss., xi. See Bot. Ztg., xl. (1882) p. 870.

necessarily so, and that Sachs' and Eichler's emergence or ligular theory may be true as to Araucarieæ, and that thus the cone of these plants is really and truly a single flower. In regard to Taxodineæ and Cupressineæ he is convinced that an inner fruit-scale really exists, completely adnate to the bract and soon outgrowing it, but he does not venture to pronounce on its nature, because he thus far has no ocular demonstration of it through any anamorphoses. Celakovsky concludes that the arillus of Taxaceæ corresponds to the ligula of Araucarieæ. He speaks of the *terminal* position of the ovule in this tribe as of very little morphological importance, the ovule being really lateral but pushed to the top of an axis.

O. Heer, the celebrated phyto-palæontologist, has shown that geologically Abietineæ and Taxodineæ are the oldest conifers now known, appearing in the Carboniferous period, while Araucarieæ come up much later, in the Triassic and Jurassic formations. But the relative geological age of the different tribes of plants is of much less importance for the appreciation of their degree of development and their position in the system, than some suppose. Thus the Cycadeæ, the Phanerogams most closely allied to Vascular Cryptogams, are, as Heer states, very uncertain in the Carboniferous, and make their decided appearance first in the Permian rocks, therefore much later than the more highly developed conifers.

To these arguments A. W. Eichler replies,* supporting his previous conclusions by considerations founded by the position of the bracts in the female flowers, and the arrangement and structure of the scales in the mature cones.

Flower adapted for Fertilization by Snails.† — F. Ludwig describes the structure of the flower of *Philodendron bipinnatifidum* (Aroideæ), which is malacophilous, i. e. incapable of self-fertilization, and fertilized only by the agency of snails, which, entering the spathe and creeping over the flowers, carry the pollen from the male to the female flowers. They appear to be attracted by an intense nutmeg-like odour, which suddenly pervades the inflorescence at the time of maturity of the stigmas, accompanied by a copious exhalation of carbonic acid.

Insects and the Cross-fertilization of Flowers.‡ — E. Heckel adheres to his view that insects are not the cause of the luxuriance of the Alpine Flora, and considers that the observations of C. Musset,§ on the simultaneous existence of insects and flowers at great heights prove that there are insects there and nothing more. M. Heckel maintains that the true cause is to be found in the greater intensity of solar radiation at these altitudes than in the plain.

Development of the Wing of the Seed of Rhinanthus.|| — The descriptions by different botanists of the seed of *Rhinanthus hirsutus*

* SB. Ges. Naturf. Freunde Berlin, 1882, pp. 77-92.
† Kosmos, vi. (1882) p. 347.
‡ Comptes Rendus, xcv. (1882) p. 1179.
§ Cf. this Journal, ii. (1882) p. 653.
|| Bot. Centralbl., xi. (1882) pp. 362-7.

All. differ in the presence or absence of a wing. O. Bachmann finds, from the examination of a large number of specimens, a wing almost invariably present, though varying greatly in size; occasionally it is altogether wanting. In an early stage it is always present, its partial or entire disappearance being due to the rapid growth of the endosperm. A minute description is given of the mode of development of the wing.

Nature of the Growing Point.*—J. Sachs discusses the constitution of the growing point in rudimentary in contrast to that in older tissues. Formative substances, such as albuminoids, oils, and carbohydrates, are not peculiar to them, but are present in the cellular tissues generally. The growing point, on the other hand, is characterized by the storing up of nuclein, and by the large size of the cell-nucleus in contrast to that in mature parenchymatous cells. It is in the tissue of the embryo that the large quantity of nuclein is especially observable; and this substance appears to have a special function in connection with the act of impregnation. The powerful action attributed to substances occurring in such small quantities is analogous to the action of ferments. If nuclein does play the part ascribed to it, it is probable that there are different kinds—one efficient in the formation of the growing points of roots, another in that of branches, and so forth.

Apical Growth in Gymnosperms.†—H. Dingler disputes the accuracy of the statement usually made that there is a universal distinction between the structure of the growing point in cryptogams and in phanerogams, in the presence of a single apical cell in the former and not in the latter. In order to elucidate the question, he has made a series of observations on the growing point of the stem of gymnosperms. The tissue was made transparent by maceration in water or treatment with potash.

A seedling of a species of *Ceratozamia* showed an evident apical cell of considerable size, in which three segments were observed; the first was undivided, the second divided into three, the third into several cells. In a seedling of *Picea excelsa* an apical cell could also be detected, but not in older plants. In *Pinus inops* a tetrahedral apical cell was also made out with less certainty, but not in *Abies balsamea* or *Pinus sylvestris* or *Laricio*. With young seedlings of *Cupressus pyramidalis*, growth by a single tetrahedral cell was determined with certainty, but not with *Juniperus communis*. In the leaf-buds of *Ephedra monostachya* no apical cell could be detected, except in a single instance.

Cell-Nucleus.‡—E. Zacharias gives a very useful and complete summary of the results of the investigations of various workers as to the formation, structure, and function of the cell-nucleus in both

* Arb. Bot. Inst. Würzburg, ii. (1882). See Bot. Centralbl., xii. (1882) p. 119.

† Dingler, H., Ueber d. Scheitelwachsthum des Gymnosperm-Stammes, 85 pp. (3 pls.). München, 1882. See Bot. Centralbl., xii. (1882) p. 154.

‡ Bot. Ztg., xl. (1882) pp. 611–6, 627–49. 651–63.

animal and vegetable cells. His own observations lead him to the conclusion that the different elements of the active nucleus are developed out of distinct portions of the nucleus when in a state of rest.

Structure and Formation of the Cell-Nucleus.*—The result of a series of observations on this subject by L. Juranyi has led him to very much the same conclusions as those of Flemming † and the later ones of Strasburger. The nucleus is composed of threads and a nucleolus. The former consists of two substances, a fundamental substance (matrix) which is not coloured, and corpuscles imbedded in it which take pigment. These increase and multiply, and finally coalesce; the threads then take the pigment along their whole length, and the nucleolus disappears. In the Cycadeæ the nucleoli are very large, and consist of a central strongly refringent corpuscle and a thick less refringent envelope, the latter being much less strongly developed in other plants. After the disappearance of the nucleolus the thread becomes gradually thicker, but one or sometimes two strongly refringent particles can be seen on the surface of the nucleus, resembling the nucleoli, but not receptive to pigment. After the threads have become much thicker and shorter they break up, the fragments either becoming applied to the wall, or touching it with one end, the rest dipping into the nuclear fluid. The protoplasm now takes the place of the nuclear fluid, and forces the fragments of the threads towards the plane of division, thus forming the nuclear plate, and the nucleus therefore consists originally of two halves. The fragments mostly take the form of a C or a U, their convex side facing the division-plane. The nuclear spindle now makes its appearance, its fibres being no doubt formed from the cell-protoplasm, as can clearly be made out in the Cycadeæ. The elements of the nuclear plate are always fragments of filaments, but the structure of the plate may vary according as its elements remain distinct, approach one another, or coalesce in consequence of the action of reagents. Reagents affect the form of the fragments so much that the plates of sister-cells may be composed of elements of quite different form, and even the elements of the same plate may differ from one another in this respect. The two halves of the nuclear plate, now fully developed, move to the pole of the nuclear spindle, the fibres of the spindle remaining behind and constituting from this time the uniting-threads. During this movement the fragments of the threads take up such a position that their concave surface faces the division-plane. After the elements of the plate have reached the pole of the spindle, they appear scarcely to move away from the uniting-threads. While this is going on, granular protoplasm is formed round them, which incloses both the fragments of the threads and a portion of the fluid between the uniting-threads and the elements of the plate, and thus is produced the vacuole in which the elements of the new nucleus lie free. The

* Ungar. Acad. Wiss. Buda-Pest, Oct. 16, 1882. See Bot. Centralbl., xii. (1882) p. 215.

† See this Journal, i. (1881) p. 11.

elements which were derived from the plate arrange themselves into a thread, which elongates and has a serpentine form.

When the daughter-nucleus divides, these processes are repeated, but the elements of the plate of the daughter-nucleus often differ in form from those of the parent-nucleus. When cell-division follows division of the nucleus, this takes place precisely in the way described by Strasburger.

Superficial Growth of the Cell-wall.* — F. Schmitz adduces further evidence in support of his previously published view † that the increase not only in thickness, but also in superficies of the cell-wall, is due not to intussusception, but to apposition. The arguments are drawn chiefly from the structure of the cell-wall in *Zygnema*, *Spirogyra*, *Ulothrix*, and other filamentous algæ, in which the outer surface of the cell-wall exhibits very fine markings or even punctations due to very minute pores. If the cell-wall was constantly being stretched by intussusception, this marking would continually increase in scale, which, however, is not the case. On the contrary, the rupture of the outermost passively stretched layer is a very common phenomenon with algæ and other plants, a fact which is in complete accordance with the theory of apposition, while it is difficult to explain on that of intussusception.

Mechanism of the Structure of the Cell-wall.‡—F. v. Höhnel has carefully examined the behaviour, under various conditions, of the cell-walls of bast-fibres and other elements in the structure of vegetable tissues. From the facts observed, he draws a conclusion adverse to the theory that the cell-wall consists of crystalline micellæ. The chief and efficient cause of the optical properties of the cell-wall he considers to be molecular tensions, which, however, occur only between the thinnest layers of the wall. The occurrence of these tensions can, he states, be absolutely proved; and experiments on fine threads of other substances are sufficient to show that they are competent to produce the phenomena of polarization. The same facts will also account for many peculiarities of the phenomena of swelling which have not hitherto been explained.

Function of Lime in Germination.§—Experiments by previous observers on *Phaseolus multiflorus* had led to the conclusion that lime has no function in connection with the transport of starch in germinating seeds; but that it is connected with the transformation of reserve into formative materials, as, for example, of starch into cellulose. A fresh series of experiments by A. von Liebenberg tends to show that plants may be divided into several groups in respect to the presence or absence of lime, and to its function in their germinating seeds, viz.:—

1. Lime is absolutely necessary when the reserve-materials are being

* SB. Versammlung deutscher Naturf. u. Aerzte in Eisenach, Sept. 19, 1882. See Bot. Centralbl., xii. (1882) p. 108.

† See this Journal, i. (1881) p. 908.

‡ Bot. Ztg., xl. (1882) pp. 595–606, 616–25.

§ SB. Akad. Wiss. Wien, lxxxiv. (1882) p. 405. See Naturforscher, xv. (1882) p. 419.

used up in germination:—*Phaseolus multiflorus* and *vulgaris*, *Pisum sativum*, *Ervum lens* and *ervilia*, *Medicago sativa*, *Soja hispisa*, *Ricinus africanus*, *Cucurbita Pepo*, *Cucumis sativus*, *Brassica oleracea*, *Cannabis sativa*, *Helianthus annus*, and *Zea Mays*.

2. The presence of lime is not absolutely necessary:—*Brassica napus oleifera*, *Sinapis alba*, *Papaver somniferum*, *Carum Carui*. It is very advantageous in *Polygonum Fagopyrum* and *Linum usitatissimum*.

3. All nutrient substances are advantageous for the development of seedlings:—*Polygonum Fagopyrum*, *Brassica oleracea* and *napus oleifera*, *Sinapis alba*, *Ricinus africanus*, *Cucurbita Pepo*, *Papaver somniferum*, *Helianthus annuus*, *Carum Carui*, and *Zea Mays*.

4. Nutrient substances promote the development of seedlings, even when lime is wanting, for a short time:—*Polygonum Fagopyrum* and *Zea Mays*.

5. One or two nutrient substances besides lime are required by the germinating seed for the consumption of the reserve-materials:—*Medicago sativa*. The researches did not positively determine whether lime is necessary for the formation of the skeleton of the cell-wall, or whether its only function is the transformation of starch into cellulose.

Structure and Function of Epidermal Tissue.*—M. Westermaier has investigated the structure and function of the epidermal tissue of plants from an anatomico-physiological point of view. Three functions are especially traceable to the peculiarities of the structure of this tissue:—1. The watery contents of the epidermal cells and the thinness of their radial walls point to a function in connection with the interchange of fluid among the cells of the epidermis itself. They constitute, in fact, a system for the storing up of water. 2. The second function relates to the interchange of fluids between the epidermal and the assimilating systems. 3. The epidermal system serves as an envelope or protection for the more delicate tissues beneath. A number of illustrations are given, in which each of these functions of the epidermis is well illustrated.

Influence of different conditions on the Epidermis of Leaves.†—In confirmation of his previous observations on the influence of abundant nutrition on the formation of stomata and of hairs,‡ E. Mer finds that the galls produced by insects on vine-leaves possess stomata, even when found on the upper side of the leaves, while, under normal conditions, stomata occur on the under side of the leaf only. The galls on the leaf-stalk of *Populus pyramidalis* have a thick-walled epidermis with a few stomata, though these are entirely wanting on the thin-walled epidermis of the uninjured part of the leaf-stalk. In *Salix*, on the other hand, the reverse is the case, stomata being present on the uninjured parts of the leaf, but not on the galls. Insolation has a marked influence on the form of the epidermal cells and on the formation of stomata, increasing the number of the latter,

* SB. K. Preuss. Akad. Wiss. Berlin, xxxvii. (1882) pp. 837–43 (1 pl.).
† Comptes Rendus, xcv. (1882) p. 395.
‡ See this Journal, ii. (1882) p. 530.

while in the former the walls become straighter and thicker, the latter being especially the case with the cuticle. The author believes the production of stomata in these cases to be the direct result of the accumulation of nutrient substances.

Influence of Light on the Assimilating Tissue of Leaves.*—As a sequel to the investigations of Haberlandt † and others on the structure of the palisade-parenchyma or assimilating tissue of leaves, H. Pick has studied the direct influence exercised on its development by the intensity of the light. In opposition to the statement of Stahl that the palisade-parenchyma is wanting on the upper surface of leaves growing in the shade, the author finds that it is in most cases present (in the case of beech-leaves and *Hieracium villosum*), but that in proportion to the want of light the length of the cells (in the direction at right angles to the surface) diminishes. In other cases the cells of this layer are round or even elongated in a direction parallel to the surface. Direct influence of sunlight on the development of the palisade-parenchyma was only rarely observed; in one case (*Osmunda regalis*) different leaves of the same plant, and even different parts of the same leaf, exhibited differences in this respect.

The author regards, however, the palisade form of cells as, in most cases, an inherited peculiarity of the mesophyll of the upper side of the leaves exposed to the action of the sun, and very rarely as affected directly by the action of light; the peculiar form of cell is partially developed even in the bud-condition. This conclusion is perfectly in accordance with the fact that the palisade-tissue is present also, though less strongly developed, on the under side of the leaf. The formation of this assimilating tissue is not prevented by a dense covering of hair, the object of which is not so much protection from too intense light as the prevention of too rapid transpiration.

In the case of "compass-plants," the structure of the leaves of which has recently been described by Stahl,‡ light appears to exercise a direct influence on the form of the assimilating tissue in the nearly erect leaves, the palisade-cells being sometimes formed on one, sometimes on the other side, according to the relative intensity of the light.

The assimilating organs have the power of always assuming a definite position with respect to the direction of the incident light, either by the heliotropism of the leaf or leaf-stalk, or by the cells themselves placing themselves in a position at right angles to the incident rays, this latter taking place with stalked leaves which are less able to alter their position in relation to light.

Development and Structure of Sieve-tubes.§—In pursuance of his previous investigations of this subject,|| E. Russow has now

* Bot. Centralbl., xi. (1882) pp. 400–6, 438–46 (1 pl.).

† See this Journal, ii. (1882) p. 368. ‡ Ibid., p. 373.

§ SB. Dorpater Naturf. Gesells., 1882, pp. 257–327. See Bot. Centralbl., xi. (1882) p. 419.

|| See this Journal, ii. (1882) p. 218.

examined the structure of the sieve-tubes, and the development of the secondary cortex in dicotyledons and gymnosperms.

In *Pinus sylvestris* the sieve-tubes are nearly square, or longer tangentially, especially in the autumn wood; their walls are thin and stratified, the tangential ones smooth, the radial and terminal provided with sieve-plates. These are divided by irregular ridges into several compartments, each of which is perforated by from three to six pores. A mixture of chloriodide of zinc, iodine, and potassium iodide colours the cell-wall blue, the callus-structure reddish-brown. The contents of the sieve-tubes, while in a functional condition, consist of a parietal layer of protoplasm, mucilage, a watery fluid, and starch-grains. At an early stage they contain several nuclei. Later they lose their contents, and the sieve-tubes are either resorbed, or remain more or less changed.

The sieve-tubes of dicotyledons may be divided into two classes: those which have sieve-plates on their more or less oblique terminal walls only, and those which have them also on their lateral walls. Those of monocotyledons agree with those of dicotyledons in essential points; they belong entirely to the second of these classes. They contain less mucilage, and usually no starch-grains. Those of Pteridophyta bear a close resemblance to those of monocotyledons, especially in the Equisetaceæ. In both cases they contain small shining spherical bodies which are coloured yellow by iodine.

Anatomy of Bark.*—J. Moeller publishes the results of a very large number of observations on the structure of the bark of various trees. As a general result he thus describes the three parts into which bark may be divided:—

1. The outer bark. The formation of cork may take place either immediately beneath the epidermis, or in the epidermis itself, or it is a second or deeper layer of the primary cortex; the inner or outer wall of the cork-cells may be sclerenchymatously thickened; the periderm may be formed at an earlier or a later period; it may be sclerenchymatous or not; the superficial periderm is sometimes permanent.

2. The middle bark. There may or may not be a collenchymatous hypoderm; the primary bundles may or may not contain bast-fibres and sclerenchymatous cells; crystals, single or in clusters, frequently occur in it, or there may be glands.

3. The inner bark. Bast-fibres and sclerenchymatous cells may both be either present or absent; there may or may not be crystals; sieve-tubes are a frequent constituent of it.

Absorption through the Epidermis of Aerial Organs.†—M. Mer states that in experiments on modes of destruction of the phylloxera, it was noticed that when the woodwork in a vinery was washed with coal-tar oil, the grapes acquired a strong flavour of coal-tar, while the vegetative organs suffered scarcely any injury. It was remarked that while the skin of the grapes remained nearly tasteless, the

* Moeller, J., 'Anatomie der Baumrinden,' 447 pp. (146 figs.). Berlin, 1882.
† Comptes Rendus, xcv. (1882) pp. 511–4.

empyreumatic substances had penetrated into the flesh, and had accumulated chiefly near the centre round the pips, and were found even in the rachis of the bunch. The skin of the grapes was also covered with an external deposit of various hydrocarbons. The conclusion to be deduced is that gaseous substances are able to penetrate even a thick epidermis, and to be absorbed by the subjacent tissue without previous solution in water.

Protein-Crystalloids of the Potato.*—According to H. Karsten the crystalloids of the potato are cells in which other cells, the "nuclear cells," are inclosed. Their growth is readily followed in boiled potatoes after digesting in slightly acid solutions of alkaline phosphates, from which treatment they in no degree lose their power of development; their cellular nature being very distinctly shown. In many respects they bear a strong resemblance to bacteria.

Hypochlorin.†—Experimenting on the hypochlorin-crystals of Pringsheim,‡ A. Meyer agrees with the conclusion of Frank § that this substance is identical with Hoppe-Seyler's chlorophyllan. He finds a convenient reagent for its solution to be glacial acetic acid. If leaves of *Iris germanica* are laid for three days in hydrochloric acid (1 part HCl and 4 parts water) until a few brown crystals appear, and then heated with glacial acetic acid, the green drops which had formed dissolve, and fresh brown crystals appear in addition to the old ones; or they can be obtained at once from the leaves by treatment with the acetic acid. The reaction of these crystals with various reagents is the same as that of those formed by the agency of hydrochloric acid, and is identical with that of chlorophyllan; a solution in castor-oil shows also precisely the same spectrum as that of this substance.

Crystals of Chlorophyll.‖—J. Borodin describes crystals obtained by the slow maceration of sections of green leaves in alcohol, and then slow drying under a cover-glass, which are not identical with the chlorophyllan of Hoppe-Seyler. They were obtained from a great variety of different plants, but only from about one-fourth of those examined, most constantly from the Pomaceæ and Amygdaleæ. They are probably a compound of chlorophyll with some unknown substance. They are much more abundant in leaves of middle age than in either the oldest or youngest. Their colour varies from pale green to nearly black, and their size and shape are very variable; they have no effect on polarized light. Their properties are constant and uniform; they differ from chlorophyllan in being very stable under the influence of sunlight, as also under that of dilute acids; they neither dissolve nor swell in hot or cold water, but dissolve

* Pharm. Centralh. f. Deutschland, iii. (1882) pp. 185-8. See Bot. Centralbl., xi. (1882) p. 341.

† Bot. Ztg., xl. (1882) pp. 530–4.

‡ See this Journal, iii. (1880) pp. 117, 480; i. (1881) p. 479.

§ Ibid., ii. (1882) p. 528.

‖ SB. Naturf. Ges. St. Petersburg (Bot. Sect.). See Bot. Ztg., xl. (1882) pp. 608, 622.

readily in alcohol, ether, and chloroform; they are quite insoluble in benzin, petroleum-ether, and bisulphide of carbon.

Crystalloids of Cupressineæ.* — According to J. Dufour the crystalloids in the seeds of Coniferæ differ in some important respects from those of other plants. In *Chamæcyparis spheroidea* the envelope of the aleurone-grains is at least partially soluble in water. The crystalloids inclosed in them are very small, about 6–12 μ long and 5–8 μ broad, and belong apparently to the tesseral system. Dilute potash-ley dissolves at first the envelope of the aleurone-grains, the crystalloids being then attacked. They increase in size, but more in one direction than the others, becoming greatly elongated, sometimes to eight or nine times their original length, before they are dissolved, and pointed at the ends. The angle also increases; and the alteration in angle and the stretching usually begin at the two ends, gradually advancing towards the middle; sometimes the stretching begins at one end only, less often in the middle. As it proceeds transverse fissures often appear, not, however, usually completely dividing them. The inference may be drawn that the crystalloids consist of transverse layers of different capacities for swelling.

Treatment with dilute acetic acid frequently causes the crystalloids to split up completely into these transverse layers. The solution of these then begins in the centre of the lamella, and advances gradually to the circumference. The results are also given of experiments on these crystalloids with hydrochloric and sulphuric acid, alcohol, and with polarized light.

Non-calcareous Cystoliths.†—H. Molisch finds, in the parenchymatous cells of *Goldfussia isophylla*, cystoliths, resembling the ordinary ones in the cortex, but altogether destitute of calcium carbonate. Among the ordinary thin-walled prismatic cells of the pith are polyhedral or cylindrical sclerenchymatous cells with very thick walls, not unfrequently 1 mm. in length; each of these idioblasts contains a non-calcareous cystolith, occupying either a portion or the whole of the cell-cavity. Sometimes the cystoliths in several adjoining cells unite, and form what appears like a single one of great length perforating the transverse cell-walls. They differ from all cystoliths previously described in being usually attached to the cell-walls by several pedicels, which are always short.

The non-calcareous cystoliths resemble the normal ones of the same plant generally in form, except that they are marked externally by wavy lines instead of ridges. The entire absence of calcium carbonate is shown by their not effervescing even with concentrated acids, nor forming crystals of calcium sulphate with sulphuric acid. Calcination also shows that they are almost entirely destitute of any mineral skeleton. The light red colour produced on addition of phloroglucin and hydrochloric acid, and the deep violet colour by previous treatment with chromic acid on addition of chlor-iodide

* Dufour, J., 'Etudes d'anatomie et de physiologie végétales' (1 pl.). Lausanne, 1882. See Bot. Centralbl., xii. (1882) p. 157.

† Oesterr. Bot. Zeitschr., xxxii. (1882) pp. 345–7.

of zinc, indicate that they are composed of slightly lignified cellulose.

The non-calcareous cystoliths are found only in the sclerenchymatous idioblasts of the medullary parenchyma, and are not, like those previously described in *Ficus elastica* and *australis*, of a pathological character. They occur also in similar situations in *Goldfussia glomerata* and *Ruellia ochroleuca*.

Tannin and Aleurone.*—J. Dufour finds that the cells of the embryo of *Borrago* are filled with aleurone-grains and drops of oil, and contain also a quantity of tannic acid. The size of the aleurone-grains varies from 1–25 μ, the usual size being from 6–13 μ. No trace of crystalloids was observed. The aleurone-grains of most Borragineæ are insoluble in water, but dissolve at once on addition of potash-ley, with explosive phenomena. In opposition to previous statements, he found tannin present in large quantities, not only in the seeds of *Borrago officinalis*, but some also in those of the majority of the plants examined; for example, in all species of Borragineæ, and in some Compositæ and Œnothereæ. In the former order *Myosotis* contained the largest quantity. From Ranunculaceæ and Solaneæ it appeared to be entirely absent. The reagent employed in detecting it was usually potassium chromate or ferric chloride, Fe_2Cl_6.

The greater number of seeds which contained tannin were without endosperm; it occurred in the embryo itself. In *Mirabilis* there is an endosperm the cells of which contain nothing but starch, both tannin and aleurone-grains being present in the embryo. The question whether tannin enters into the composition of the aleurone-grains when they are both present in the same cell, the author is unable at present to decide.

Phænological Inversions.†—By this term L. Rahn understands the inversion of the ordinary succession of blossoming in flowers, caused by abnormal meteorological conditions. From observations extending over twenty years in the botanic garden at Giessen, he states that the time of the first opening of flowers depends not only on the minimum daily temperature, but also on the amount of precipitation of moisture, and lays down the following general rules:—(1) The blossoming of any particular plant depends on a certain sum of temperature, which should be reckoned in our latitudes from about the 1st of January; and, secondly, on the height of the mean daily minimum temperature. (2) A minimum above the mean corresponds to an earlier, a minimum below the mean to a later mean blossoming. (3) The influence of the daily minimum is balanced by a high daily sun-maximum, by precipitation of moisture at the time of blossoming, by general moisture, by a striking deficiency in the daily precipitation, by general dryness, and by the action of late frosts. (4) High sun-maxima may altogether counteract the retarding action of a low daily

* Dufour, J., 'Etudes d'anatomie et de physiologie végétales.' Lausanne, 1882. See Bot. Centralbl., xii. (1882) p. 156.

† Ber. Oberhess. Gesellsch. Nat. u. Heilkunde, xxi. (1882) pp. 113–44 (1 pl.). See Naturforscher, xv. (1882) p. 401.

minimum. (5) Precipitations which take place with a high minimum always delay the first blossoming. (6) Precipitations with a low minimum always result in early blossoming. (7) Moisture preceding the first blossoming always causes retardation. (8) Deficiency of moisture causes early blossoming when the daily minimum is low, late blossoming when the daily minimum is high. (9) Frosts cause a delay in the first blossoming when they do not kill. (10) Irregularities in the normal succession are proportionate to the difference in organization of the species concerned and to the intensity of the factors which compensate the effects of the mean daily minimum. (11) Inversions are extreme cases of this irregularity, and are usually the result of precipitations of moisture. (12) Plants with deep roots are less affected by drought than by moisture; the former acts chiefly on those which do not root deeply.

Protection of Plants from the Lower Fungi.*—W. O. Focke points out that plants, especially in their older portions, and during the resting periods of their active life, are little fitted to withstand the attacks of the lower fungi, and that there are certain means of protection provided them against the attacks of these enemies, which accounts for their suffering so comparatively little from them.

As such, he names a firm epidermis, especially when it is protected by a coating of wax against the retention of moisture. A further protection, especially to stems, is the corky layer of the bark, which, besides being itself a very resisting substance, often contains chemical matters which are injurious to the lower organisms, for example, poisons, tannin, alkaloids, and wax. The underground portions of plants, especially of those growing in marshes, secure themselves, partly by a firm epidermis, partly by means of the chemical substances named (tannin for example in *Alnus* and *Comarum*, alkaloid in *Cicuta*, &c.). Evergreen leaves have also, besides their protection against plant-eating animals (spines, poisonous qualities, and leathery consistence), such safeguards as are necessary against the attacks of fungi, and which again consist of a firm epidermis (*Ilex*), and the possession of some one or more chemicals (poison, alkaloids, &c.). The durability of the succulent fruits which serve such a distinct purpose in the propagation of plants by animals (birds), appears in many cases likewise to have been caused by these means; while in regard to seeds, which for the most part remain dormant during the winter, either in or upon the earth, these are both protected and preserved by their stout outer covering and by similar chemical substances. Further, the author believes that the fatty oil so frequently found is as valuable for protection as for nourishment. The oil, as well as the husks, checks the absorption of water at a low temperature, without which the dry seeds cannot be attacked by the fungi of putrefaction. The volatile oils also serve in many plants as a protection against injury by the sun. When there is any scarcity of water in the soil, by their evaporation they lower the temperature; and, according to Tyndall, when these oils are present only in a small degree in the air, they

* Kosmos, v. (1882). See Bot. Centralbl., xi. (1882) pp. 64–5.

deprive it to a great degree of its diathermancy, so that the fragrant clouds which in a dry neighbourhood spread themselves above odoriferous plants, protect them no less from the parching rays of the sun than from nocturnal radiation.

Detmer's Vegetable Physiology.* — The second part of W. Detmer's 'System of Vegetable Physiology,' which forms a part of the 'Encyklopædie der Naturwissenschaften,' treats of the following subjects:—The general properties of the growing parts of plants, and the nature of the process of growth; the phenomena of growth caused by internal conditions of growth; the essential conditions of growth, and the influence of external conditions on growth; the natural direction of the parts of plants; and the movements of variation, that is, those which take place only in the mature parts.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Chætopterideæ.†—M. Kuhn divides the large order of Polypodiaceæ primarily into the two groups of the smaller Chætopterideæ and the larger Lopidopterides. The former are distinguished by the creeping rhizome having only a single closed vascular-bundle-tube, and being covered only with delicate few-celled paleæ; while the latter have an erect or creeping rhizome, penetrated by one or more fibro-vascular bundles which do not form a closed tube, and bearing scaly paleæ instead of hairs. The following is an analysis of the tribes:—

Chætopterideæ. Rhizoma repens, setosum; paleæ e paucis cellulis formatæ, quasi setæ Hymenophyllacearum, basi plana affixæ; tubus fasciculi vasorum in rhizomate semper clausum.

A. Sori exindusiati.

Tribus I. *Gymnogrammeæ.*

B. Sori indusio vero s. spurio obtecti.

Tribus II. *Lindsayeæ.* Sori in apice nervorum s. in anastomosi nervorum complurimum indusio obtecti; receptaculum nullum; margo immutatus, non revolutus.

Tribus III. *Lonchitideæ.* Sori semper in anastomosi nervorum, margine revoluto (indusio spurio) obtecti; indusium verum minutissimum, basi anastomosis nervorum affixum.

Tribus IV. *Microlepieæ.* Sori singuli apicales s. subapicales, margine revoluto s. indusio infero vero obtecti; receptaculum liberum.

* Schenk's 'Handbuch der Botanik,' ii. (1882) pp. 447–555. Cf. this Journal, ii. (1882) p. 223.

† Festschrift z. 50 jähr. Jubil. d. Königstädt. Realschule zu Berlin, pp. 321–48 (2 pls.) 1882. See Bot. Centralbl., xii. (1882) p. 188.

The genera belonging to the first tribe are characterized as follows, viz. :—

Gymnogrammeæ. Rhizoma repens, setosum, setis basi affixis; sori exindusiati; petiolus rhizomate continuus; nervi apice non incrassati (excl. gen. *Cheiropleuria*).

A. Fasciculi vasorum petioli 1–3; paraphyses sporangiis admixtæ s. pedicellis sporangiorum insertæ.

a. Sori *Gymnogrammes.*

1. *Aspleniopsis.* Sori nervorum partem occupantes.
2. *Trichiogramme.* Sori omnes nervorum partes occupantes.

β. Sori costæ paralleli, medii inter costam et marginem.

3. *Tœnitis.*

γ. Sori *Acrostichi.*

4. *Platytœnia.* Folia pinnatisecta, segmenta maculis *Doodyæ.*
5. *Cheiropleuria.* Folia indivisa s. dichotoma, nervi flabellati ramis *Drynariæ* maculis junctis.

B. Fasciculi vasorum petioli 1 s. 2; paraphyses nullæ; sori *Gymnogrammes.*

6. *Psilogramme.* Folia in costis nervisque hirsuta; sori e basi nervorum versus apicem decrescentes.
7. *Gymnogramme.* Folia glaberrima; sori apicem nervorum occupantes.

C. Fasciculi vasorum petioli 2; paraphyses paucæ; sori apicem nervorum occupantes.

8. *Monachosorum.*

Aspleniopsis contains 1 species (Polynesia); *Trichiogramme* 11 sp. (S. America, E. Indies, Polynesia); *Tœnitis* 1 sp. (Tropical Asia to Japan); *Platytœnia* 1 sp. (Philippines); *Cheiropleuria* 1 sp. (China, Japan); *Psilogramme* 33 sp. (S. America, Tristan d'Acunha); *Gymnogramme* 4 sp. (1 occurring in Europe); *Monachosorum* 1 sp. (E. India, Java).

Of the remaining tribes Lindsayeæ includes *Lindsaya* (43 sp.); *Schizoloma* (25 sp.); *Wibelia* (3 sp.); *Odontosoria* (3 sp.); and *Lindsayopsis* (3 sp.); Lonchitideæ includes *Histiopteris* (2 sp.), *Lonchitis* (6 sp.), *Pteridium* (*Pteris* 1 sp.), *Antiosorus* (2 sp.), and *Paesia* (5 sp.); and Microlepieæ or Dennstaedtieæ comprises *Hypolepis* (14 sp.), *Microlepia* (15 sp.), *Leptolepia* (4 sp.), and *Dennstaedtia* (24 sp.).

Development of the Spores of Salvinia.*—According to E. Heinricher, the octant-cells in the sporocarp of *Salvinia* are the mother-cells of the spores, of which there are therefore only eight. The octants of one half of the archespore occupy such a position with respect to those of the other half, that the walls which separate the

* SB. K. K. Akad. Wiss. Wien, lxxxv. (1882) pp. 494–522.

octants form with one another an angle of 45°. When the octants, unequal in size, separate from one another, the formation of tetrahedra commences, but not simultaneously in all the octants. The macrospore proceeds from a tetrahedron, which is always surrounded by a clear border, like that which distinguishes the tetrahedra, and which may be attributed to the conversion into mucilage of the wall of the special mother-cells. As the sporangial capsule grows, the protoplasmic ball, with the macrospore, becomes more and more closely applied to one of the walls of the sporangium. The macrospore now grows more rapidly, and its membrane begins to thicken, forming the exospore. The tapetal cells still always retain their nuclei. In the hardened epispore there appear more strongly refringent particles between the vacuoles, which must be regarded as the remains of the nuclei of the tapetal cells. The microsporangia form sixteen spore-mother-cells. Each of the microspores is surrounded by a clear border; and here also the tapetal cells still retain their nuclei.

Two teratological examples at this point were observed. One consisted of a double sporangium, which was divided in a direction at right angles to its longer diameter, each half forming its separate archespore. The other was a hermaphrodite sporocarp, containing a number of microsporangia and five macrosporangia.

The author considers that the facts here recorded still further accentuate the separation of the Rhizocarpeæ into the two groups of Marsileaceæ and Salviniaceæ. The sexual differentiation of the sori in *Salvinia* must be regarded, from a phylogenetic point of view, as an advance in structure in comparison with *Marsilea;* the occasional hermaphrodite sporocarps of *Salvinia* being referable to atavism. A further evidence of advance is the formation of only eight spore-mother-cells in the macrosporangium of *Salvinia*, in contrast to the sixteen in *Marsilea*. Another indication of advance is that from this point only one spore is required in order to produce a macrospore, while in *Marsilea* one spore from each tetrahedron grows more rapidly, one of these then developing into the macrospore. Whether the Marsileaceæ or the Salviniaceæ is considered as the more advanced group depends on the relative importance attached to the asexual or to the sexual generation. Possibly the two are derivations from a common ancestral form.

Muscineæ.

Structure and Classification of Muscineæ.* — S. O. Lindberg publishes a succinct account of the morphology of the entire group of Muscineæ, including both exotic and European forms. After contrasting the earliest stages of development with those of vascular cryptogams, he describes the germination and the protonema-stage, the root, the stem, the leaves, the "inflorescence," the sexual organs, the sporogonium, and finally the spore-plant, composed of calceolus, seta, theca, and spores. Under each heading, the Hepaticæ, Sphag-

* Lindberg, S. O., 'Europas och Nord Amerikas hvitmossor (Sphagna) jämte en inledning om utvecklingen och organbildningen inom mossornas alla tre grupper.' (Swedish with Latin diagnoses.) 116 pp. Helsingfors, 1882. See Bot. Centralbl., xi. (1882) p. 373.

naceæ, and Musci are fully described, and compared with one another. In accordance with his views previously published, Lindberg considers the organs of mosses which bryologists describe as the "flower," to correspond, not to the flower, but to the inflorescence of flowering plants.

The Hepaticæ are divided by the author into two sections:—Calyptra gynogena, including *Lejeunia*, *Frullania*, &c., in which the archegonia are stalked; and Calyptra thalamogena, including *Riccardia*, *Lepidolæna*, *Trichocolea*, &c., in which the lower part of the imbedded archegonium is formed from the stem, which therefore takes part in the formation of the sporogonium.

In *Sphagnum* Lindberg is unable to detect the two kinds of spore described by Schimper; they are all of the same size. In this family he gives accurate descriptions of transverse sections of the leaves.

The following is his classification of the species of *Sphagnum*:—

I. Eusphagnum. A. Sphagna palustria (*S. portoricense*, *imbricatum*, *papillosum*, and *palustre*). B. S. subsecunda (*S. tenellum*, *laricinum*, and *subsecundum*). C. S. compacta (*S. Angstroemii*, *molle*, and *compactum*). D. S. cuspidata (*S. squarrosum*, *fimbriatum*, *strictum*, *nemoreum* (*acutifolium*), *Wulfii*, *Lindbergii*, and *cuspidatum*, with its varieties).

II. Isocladus (*S. macrophyllum* and *cribrosum* n. sp.).

III. Hemitheca (*S. Pylaiei* and *cyclophyllum*).

The last section should probably be erected into a distinct genus, with the following characteristics:—Foliis et bracteis fere conformibus, eisdem trunci multo majoribus quam ramorum; ramis femineis brevibus, e medio trunci egredientibus; fibris cellularum inanium valde peculiaribus.

Fungi.

Abnormal Hymenomycetes.*—F. Ludwig records several instances of abnormality in Hymenomycetes, resulting from sudden alternations in growth caused by the occurrence of occasional warm dry days in a very wet season. The species in which this was noticed were *Hydnum repandum*, *Lactarius ichoratus*, *Russula depallens*, *Cantharellus cibarius*, *Agaricus* (*Dermocybe*) *cinnamoneus*, *A.* (*Inoloma*) *amethystinus*, and *A.* (*Citocybe*) *laccatus*. They consisted mostly of secondary pilei springing from the normal pileus, sometimes of secondary stipites springing from the normal stipes; these sometimes ended in pilei, sometimes were barren. The secondary pilei were frequently of different shape from the normal one, and sometimes did not bear lamellæ.

Phosphorescent Agaric.†—The phosphorescent species of Agaricini are at present limited to those the mycelium of which constitutes the different kinds of so-called "rhizomorpha." F. Ludwig is now able to add to the list *Agaricus* (*Collybia*) *tuberosus*, the resting condition of which is known as "sclerotium cornutum." The sclerotia may either develope into mycelium, or may form the fructification direct. In the dark the mycelium of this species is distinctly

* Bot. Centralbl., xii. (1882) pp. 136–8. † Ibid., pp. 104–6.

phosphorescent, resembling that of the rhizomorph-forming fungi. It is probable that other allied species may exhibit a similar phenomenon.

New Ascomycetes.*—W. Voss describes two interesting new Ascomycetes, *Phacidium gracile*, parasitic on *Lycopodium chamæcyparissus*, and *Leptosphæria Fuckelii*, on *Calamagrostis sylvatica*, both from the neighbourhood of Laibach. The latter occurs on a number of grasses, and is distinguished from the most nearly allied species by the peculiar form of the spores. They are nearly cylindrical, broadly rounded above, and the projecting fourth cell lies about the middle of the spore, only two rather larger cells lying beneath it. In allied species the projecting cell is the second or third (from the top), from four to seven cells lying beneath it. Its habit is that of the much more common *L. culmifraga*.

New Entyloma.†—P. Magnus describes *Entyloma Helosciadii*, a new species parasitic on *Helosciadium nodiflorum*, only the second species of this genus known to be parasitic on plants belonging to the Umbelliferæ. It is distinguished from the most nearly allied species by the small size and long form of the spores.

Coremium of Verticillium.‡—E. Eidam describes the formation of coremia on *Verticillium ruberrimum* parasitic on potatoes. They form dry feathery tufts 1–1·5 cm. long, which are swayed by the least breath of wind. From 5 to 20 fertile hyphæ unite in the formation of a coremium, from which radiate on all sides well-developed filaments of spores with the characteristic verticillate branches.

Exoascus.§—R. Sadebeck discusses the characters of the various species of *Exoascus*, which are parasitic upon, and often very destructive to, different trees. He points out that the statements that the formation of the asci is not preceded by that of a mycelium, rests upon inaccurate observation. The distinct genus *Ascomyces* proposed by Magnus must therefore fall to the ground. There are on the alder two parasitic species of this fungus, differing very much in appearance, but resembling one another in their course of development.

Sporendonema casei Desm.‖—In addition to the ordinary fructification of this fungus, cultivated on a decoction of dung, E. Eidam observed hitherto undescribed reproductive organs. On anastomosing mycelial cells a quantity of small protuberances made their appearance, which unite into rounded pseudo-parenchymatous bodies. The cells composing these bodies are filled with oil and protoplasm; they finally swell greatly, and the cortical portion of the mass passes

* Oesterr. Bot. Zeitschr., xxxii. (1882) pp. 357–9.

† Hedwigia, xxi. (1882) pp. 129–30 (1 pl.).

‡ JB. Schles. Gesellsch. vaterl. Cult. Breslau, lviii. (1881) pp. 137–8. See Bot. Centralbl., xi. (1882) p. 298.

§ Versamml. Deutsch. Naturf. u. Aerzte zu Eisenach, 1882. See Bot. Centralbl., xii. (1882) pp. 179–81.

‖ JB. Schles. Gesellsch. vaterl. Cult. Breslau, lviii. (1881) pp. 139–40. See Bot. Centralbl., xi. (1882) p. 298.

through brown to black. After remaining for some time at rest they produce smooth oval spores with a brownish-red nucleus, which germinates, reproducing the cycle of generations.

Entomophthoreæ.*—L. Nowakowski gives the following as the chief results of a fresh examination of this class of fungi:—

The resting-spores of *Entomophthora ovispora*, *curvispora*, and *conica* n. sp., are true zygospores, the product of an undoubted act of conjugation.

In the formation of the resting-spores (azygospores) of *E. radicans*, a transition is seen from sexual to the non-sexual reproduction of the other Entomophthoreæ.

In *Empusa Grylli* (*Entomophthora Grylli* Fr.), on *Culex pipiens*, *C. annulatus*, and *Gomphocerus biguttulus*, the resting-spores are formed non-sexually, the protoplasm escaping from the cells of the mycelium and becoming encysted. The young resting-spore is then separated by a septum from the empty mother-cell, the cell-wall of which becomes rapidly absorbed. Resting-spores formed in the autumn germinated the following spring. The endospore bursts through the outer layer and lengthens into a septated hypha, which detaches with violence a conidium from its apex.

A columella similar to that of *Pilobolus* and of *Completoria complens* occurs also in the following species:—*Entomophthora ovispora*, *curvispora*, *conica*, *aphidis*, *radicans*, and *Empusa Grylli*, but is wanting in *Empusa Freseniana*, n. sp., parasitic on various aphides, and in *Lamia* (*Empusa*) *culicis*.

The author considers the Entomophthoreæ to belong to the Zygomycetes, and divides them into three genera:—1. *Entomophthora*, conjugation evident or obscure. 2. *Empusa*, conidia-bearing hyphæ unbranched, resting-spores formed as described above in *E. Grylli*. 3. *Lamia*, conidia-bearing hyphæ unbranched; mycelium filiform, with organs of attachment; resting-spores formed in the apex of the hyphæ, like the conidia, but the conidia are larger and spherical.

The warty opaque walls of the resting-spores of *Tarichium* differ from those of the other Entomophthoreæ, hence its true position is at present doubtful, especially as its conidia are still unknown.

Entomophthora rimosa Sorokin is identical with *Empusa culicis* A. Br. and possibly his *E. conglomerata* with *E. Grylli* Fr.

Completoria complens, described by Leitgeb † as parasitic on the prothallia of ferns, probably belongs to this group.

Influence of Acids on Fermentation and on the Development of Torula.‡—M. Hayduck finds that different acids have a very different effect on the production of *Torula*, and that their influence on the process of fermentation is not always in proportion to this. A smaller quantity generally hinders the production of *Torula* than its

* SB. Akad. Wiss. Krakau, March 20, 1882. See Bot. Ztg., xl. (1882) p. 560.

† See this Journal, ii. (1882) p. 377.

‡ Zeitschr. f. Spiritusindustrie, iv. (1881) p. 341.

fermenting power, while very small quantities of acid may even have a beneficial effect on both processes. This fermentation is promoted by 0·02 per cent. of sulphuric and 0·2–1·0 per cent. of lactic acid; hindered by 0·2 per cent. sulphuric, 0·1–0·18 per cent. hydrochloric, 0·4–0·5 per cent. phosphoric, and about 2·5 per cent. lactic acid; and altogether prevented by 0·7 per cent. sulphuric, 0·5 per cent. hydrochloric, more than 1·3 per cent. phosphoric, and more than 4·6 per cent. lactic acid. The development of *Torula* is promoted by 0·02 sulphuric and 0·1–0·5 per cent. lactic acid; hindered by 0·07 per cent. sulphuric and 1·5 per cent. lactic acid; and prevented by 0·2 per cent. sulphuric and 4·0 per cent. lactic acid.

Influence of Alcohol on the Development of Torula.*—M. Hayduck has experimented on the influence on the production of *Torula* of alcohol itself, and of the subsidiary products of fermentation, succinic acid, glycerin, nitrogenous excretory products, and fusel-oil. The small quantity of succinic acid produced in fermentation he finds to have no injurious effect on the production of *Torula;* nor does glycerin hinder fermentation, when present to the extent of 10 per cent. The nitrogenous products are also without injurious effect; while fusel-oil acts most prejudicially if present to the amount of 0·5 per cent., 2 per cent. of it entirely stopping fermentation. Alcohol itself hinders fermentation when present in small quantities; a proportion of 15 per cent. entirely stopping it. From 2–6 per cent. of alcohol in a saccharine solution greatly injures the development of *Torula*, while an admixture of 10 per cent. appears to stop it altogether.

New Species of Mortierella (Mucorini).†—J. Therry and Thierry describe two new species of *Mortierella* found in gardens in the neighbourhood of Lyons, one (*M. arachnoides*) in hothouses, the other (*M. Ficariæ*) parasitic on the leaves of *Ficaria ranunculoides*. The former is remarkable for the very rapid growth of the mycelium, the filaments lengthening as much as several metres in a single night, without branching or anastomosing. Both have an extraordinarily rapid destructive effect on their hosts, killing the leaves in the open ground in three or four days, under a bell-glass completely disorganizing them in three or four hours.

Development of Mould-Fungi in the Bodies of Men and other Animals.‡—T. Leber records an instance of purulent ceratitis in the eye caused by a fungus-mycelium introduced into the cornea on a glume of an oat. Experimenting on rabbits, he found that the spores of *Aspergillus glaucus* introduced into the eye in the juice of fruits germinate freely; and equally at a temperature of 14° or of 35°–37° C. This capacity of germination in the bodies of animals appears to take place whatever the previous condition of the fungus, and independently of

* Zeitschr. f. Spiritusindustrie, v. (1882) p. 183. See Bot. Centralbl., xii. (1882) p. 4.

† Revue Mycol., iv. (1882) pp. 160–2 (1 pl.).

‡ Berl. klin. Wochenschr., 1882. See Bot. Centralbl., xi. (1882) p. 317.

the assistance of man. Similar experiments with *Penicillium* altogether failed; but this was probably the result of conditions of temperature, a temperature of 34°–38° C. destroying the germinating power of the spores of *Penicillium*. *Aspergillus nigrescens*, on the other hand, while thriving at the temperature of the body, did not develope in the cornea; the cause in this case being possibly its alkaline reaction. *Leptothrix buccalis*, which occurs abundantly in the mouth, was found to develope also in the cornea, undergoing no change from its altered conditions. The author's experiments on this point were altogether favourable to the view of the constancy of species.

Physiological Effects of various Ferments.*—Ph. Van Tieghem reports the results of a series of investigations made by M. Gayon on the influence of various ferments on different fermentable liquids.

Mucor circinelloides, when vegetating without free oxygen, behaves precisely like *Saccharomyces cerevisiæ* in contact with the wort of wine or beer; the beer obtained from it being very limpid and of a sweet somewhat plum-like taste. But with cane-sugar this organism produces no inversion, and consequently no fermentation. But if into the liquid is introduced a small quantity of invertine, or any fungus, like *Penicillium*, which produces invertine, fermentation of the inverted sugar immediately sets up; and the *Mucor*, acting from this time like *Penicillium*, destroys first the glucose, and then the levulose.

In the absence of the power of inverting cane-sugar *Mucor circinelloides* resembles *M. spinosus* and *Mucedo* and *Rhizopus nigricans;* and these experiments determine directly for the first time that the inversion of cane-sugar must necessarily precede its fermentation, in other words, that it is not directly fermentable. The various species of *Saccharomyces* behave differently in relation to cane-sugar; some, like *S. cerevisiæ*, inverting it, while others, like *S. apiculatus*, are wanting in this power.

From these facts M. Gayon draws some applications which may be of great importance from an economical point of view; as, for example, in the separation of cane-sugar from other saccharine fluids, for example molasses. The reducing sugar may be destroyed by fermentation with *Mucor*, while the cane-sugar remains unaltered, and may be crystallized. He is also able to account for the reducing sugar which gradually forms in crude cane-sugar, and sometimes in that of beet. This sugar is inactive, and if this results from its essential nature the mixture ought, when fermented by *Mucor*, always to preserve its primitive rotation to the right. If, on the contrary, it is neutral because it consists of a compensating mixture of glucose and levulose, then, when fermented with *Mucor*, the power of rotating to the right ought to diminish as the glucose disappears, then to increase from the destruction of the levulose, and finally reassume its original value. Experiment favours this latter conclusion, and proves that the reducing sugar is an inverting sugar, in which the opposite powers of rotation exactly neutralize one another.

* Ann. Sci. Nat. (Bot.) xiv. (1882) pp. 46–9.

Carriage of Schizomycetes through the Air.*—C. v. Nägeli and H. Buchner have determined that bacteria and similar organisms are not taken up into the air simply by evaporation of the fluids in which they live, nor are they detached from a solid substratum by currents of dry air only. In order for the germs to be dispersed through the air, they must first be scattered by drops of water, and are then taken up by currents of air. This view is of importance in connection with the spread of malarial fevers.

Transition between Forms of Schizomycetes.†—C. v. Nägeli is of opinion that all known forms of Schizomycetes are connected by intermediate links, and that any division into species, however convenient for the purpose of description, has no scientific value. There is no doubt that the same species occurs in widely different forms dependent on the mode in which it obtains its nourishment.

Fatty Bodies as Generators of Bacteria.‡—T. Brisson de Lenharée points out that fatty substances on mineral bodies or used in the hair, such as oil, pomade, glycerin, &c., attract the numerous minute germs, especially those of parasitic fungi, which abound in the air; glycerin, however, is not so deleterious in this way as the other substances named. Hence a very common source of baldness. Building and funereal stones which had been soaked in oil in order to protect inscriptions on them from the influence of the weather were found to have been much attacked by minute fungi from the very means used to protect them.

Phosphorescence caused by Bacteria.§—N. Patouillard describes a specimen of *Agaricus acerbus* Fr. from the Pyrenees which was strongly phosphorescent. A microscopic examination showed that the phenomenon was due to innumerable bacteria allied to *Bacterium catenula* Eh., mobile and colourless, composed of a variable number of cylindrical rods placed end to end, forming a straight or curved chain. They were accompanied by a great number of another organism allied to *Saccharomyces*, consisting of a hyaline refringent globule, often with a brilliant point in its centre, which increased by gemmation after the ordinary manner of a torula. Both of these organisms were found at a considerable depth in the tissue, as well as near the surface.

The phosphorescence of fungi is therefore due to two causes: first, to the action of oxygen on the tissue of the fungus itself, as in the case of *Agaricus olearius*, rhizomorpha, and exotic luminous species; secondly, to the accidental presence of parasitic luminous organisms.

Inoculation of Tuberculosis through Respiration.‖—In order to ascertain whether the germs of tuberculosis, if present in the air, can

* Med. Centralbl., xx. (1882) p. 513. See Naturforscher, xv. (1882) p. 364.

† Unters. über niedere Pilze aus dem pflanzenphysiol. Instituts München, i. (1882) pp. 129–39.

‡ Actes du Congrès de la Rochelle, Sect. Bot., 1882. See Rev. Mycol., iv. (1882) p. 249.

§ Rev. Mycol., iv. (1882) pp. 208–9 (1 pl.).

‖ Comptes Rendus, xciv. (1882) p. 1391.

be inhaled by respiration, Giboux prepared two boxes, in each of which he placed two young rabbits, and passed daily through each of them 20,000–25,000 c.c. of air, which had been exhaled by phthisical patients of the second and third degree. With one of the boxes the air was first filtered through a wad of cotton-wool. After about three and a half months, the rabbits in the unprotected box died, having suffered loss of appetite, thirst, diarrhœa, &c., and the lungs, liver, and spleen were found to be tuberculated. In the protected box, on the contrary, the rabbits were still perfectly healthy, and on autopsy not a trace of tuberculosis was to be found.

Parasitic Myxomycetes.*—W. Zopf describes a new myxomycete, *Haplococcus reticulatus*, belonging to the Monadineæ, and specially to the Vampyrelleæ, which settles in great quantities in the muscles of swine. Its structure is extremely simple, exhibiting two stages of development, sporangia and resting-spores. The sporangia are globular, and their membranes are thin in places where the delicate inner wall protrudes in the form of papillæ. The protoplasmic contents break up into portions which display amœboid motions, and finally escape as amœbæ through the gelatinized papillæ. The resting-spores are globular or tetrahedral with rounded corners, resembling the spores of some ferns. Their strongly thickened and cuticularized membrane is marked with ridges which form a beautiful network. The author has not determined whether the parasite has an injurious effect on the host, or renders its flesh unfit for food.

Algæ.

Marchesettia, a New Genus of Florideæ.†—Under the name *Marchesettia spongioides*, F. Hauck describes a new type from Singapore, Madagascar, and New Caledonia, belonging to the Areschougiaceæ. The thallus is spongy and cartilaginous. The reproductive organs are placed on special fertile branches, which are sometimes scattered over the thallus, but more often collected into tufts at the apices of the branches, and are formed from the growth of the outer branches of the filaments of the thallus. The fertile have the same structure as the vegetative branches, but in their fertile portions the cells of the outer layers are considerably smaller. The cystocarps are sessile on the fertile branches, broadly ovate, with moderately thick cellular pericarp open at the apex, which incloses a simple or lobed roundish nucleus, composed of a large, branched, basal, placental cell, the peripheral branches of which radiate into crowded tufts of branched segmented carpogenous filaments, the upper cells of which become carpospores. The tetrasporangia are formed in somewhat club-shaped fertile branches, the upper portion of which is swollen into a nemathecium, which developes, by the growth of the cortical cells, into short rows vertical to the surface; between these are placed the longish, very irregularly divided tetrasporangia.

* SB. Bot. Ver. Prov. Brandenburg, 1882, pp. 55–6.
† Hedwigia, xxi. (1882) pp. 140–1.

Chromophyton Rosanoffii.*—N. Wille found, associated with *Conferva*, *Orthosira*, *Spirogyra*, and *Mougeotia*, a brown palmella-like organism which he identified with Woronin's *Chromophyton Rosanoffii*.† As described by the discoverer, he found two kinds of zoospores, one smaller and rounder, the other larger and ovoid, each with a single cilium. After swimming about, they attach themselves by the anterior ciliated end to a filamentous alga, and become encysted; the encysted form contains a red eye-spot, and again developes zoospores.

The organism which proceeds from the ovoid zoospores is identified by Wille with Ehrenberg's flagellate *Epipyxis utriculus*, and the one which proceeds from the spherical zoospores with Stein's flagellate *Chrysopyxis bipes*. He concludes therefore that *Chromophyton Rosanoffii* is not an independent organism, but that it must be regarded as a palmella-form of two flagellate Infusoria.

Phyllosiphon Arisari.‡—F. Schmitz has undertaken a fresh examination of this organism, parasitic in Italy on the leaves of *Arisarum vulgare*; his results differing in some respects from those already obtained by L. Just.§

The thallus of the parasite spreads extensively through the intercellular spaces of the parenchyma immediately beneath the palisade-parenchyma of the leaf; and in these spaces the filaments branch normally and almost invariably dichotomously, lateral branches being very rarely seen. Their average diameter is from 25 to 35 μ; when the apical growth has ceased they increase in diameter to about 60 μ, and the formation of spores commences. The filament dichotomises repeatedly, and thus becomes changed into a more or less ramifying tuft of branches of equal or unequal length, which are sometimes swollen into a club-shape at the extremity. The spores then begin to be formed in the interior. This portion is, however, never separated from the rest of the thallus by a septum. The vegetative and the spore-forming stage of the thallus are not sharply separated the one from the other. The wall of the filament is simple at the growing extremity, double in the older parts, the outer layer being cuticularized. The growing apices of the filaments contain a parietal layer of protoplasm, with strings of the same substance crossing the central cavity, and containing drops of oil. The protoplasm contains a number of nuclei of irregularly spherical or lenticular form, each of which has usually a nucleolus; the nuclei increase rapidly by division.

In the growing apices the protoplasm is completely colourless, but further backwards it gradually assumes a yellowish green and ultimately green colour. This is not due to a general colouring of the entire protoplasm, but to a number of excessively minute disk-shaped chlorophyll bodies dispersed through it. It contains also a number of globular starch-grains, which vary greatly in size, and

* SB. Bot. Ver. Prov. Brandenburg, 1882, pp. 49–50.
† See this Journal, i. (1881) p. 100.
‡ Bot. Ztg., xl. (1882) pp. 523–30, 539–55, 563–73, 579–83.
§ See this Journal, ii. (1882) p. 391.

differ in some of their reactions from ordinary starch, and may possibly be sphero-crystals.

The entire protoplasm of the filaments from the apex to the base of the last branch is used up in the production of the spores, with the exception of the outermost parietal layer, which remains behind between the spores. This always results from a small mass of protoplasm surrounding one of the small nuclei and containing a single disk-shaped chlorophyll body becoming separated off to an independent existence. These are rapidly inclosed in a membrane, and become the ellipsoidal spores, which contain a colourless homogeneous protoplasm, a single chlorophyll-disk attached to one of the longer walls, a nucleus, and drops of oil. The spores vary greatly in size, the average length being from 2–6 μ, and the average breadth from 1·5–2·5 μ.

The minute spores escape in vast numbers in a dark-green mucilage to the surface of the leaf, the outer layer of the wall of the filaments bursting in consequence of the eager absorption of water by the inner layer. Some, however, remain within the filaments, where they show the first indications of germination. Further stages of germination were not observed.

With regard to the systematic position of *Phyllosiphon*, Schmitz is disposed to place it in or near the Siphoneæ. It differs, however, essentially from *Vaucheria* in the mode of reproduction and of formation of the spores, and displays greater affinity to *Udotea*, *Holimeda*, and some allied genera. From the latter it differs chiefly in the spores being inclosed in a membrane and motionless instead of being naked and biciliated.

Argentine and Patagonian Algæ.*—O. Nordstedt has examined algæ sent by Professor G. Hieronymus from the Argentine Republic and Patagonia, some of which were found in the neighbourhood of Córdobas, in the Cordilleras of the province Rioja, and in the Sierras Famatina and Velasco; while others were collected by P. G. Lorenz and G. Niederlein on the military expedition of the Argentine General Roca to the Rio Negro. Thirty-seven kinds are determined, belonging to twenty-three genera, besides undetermined kinds (mostly sterile Zygnemaceæ) belonging to seven other genera. The following are the new forms:—*Penium conspersum*, Wittr. *β americanum*, with four chlorophyll-masses as in *P. interruptum*; *Cosmarium gemmiferum* Bréb., a form which resembles *C. Quasillus*; *Tolypothrix penicillata* (Ag.?) Thuret, *β gracilis*, and some other forms differing but slightly from the European. The alga-flora of the countries in question agrees very closely with the European, there being only three kinds which do not also appear in Europe: *Euastrum quadratum* Nordst., *Vaucheria Hookeri* Kütz., and *Batrachospermum* (*Dillenii* var.?) *Puiggarianum* Grun.

Swedish Pediastreæ, Protococcaceæ, and Palmellaceæ.†—G. Lagerheim describes 68 species, belonging to 29 genera, of algæ from

* Bot. Notiser, 1882, pp. 46–51.

† Ofversigt af kongl. Vetensk.-Akad. Förhandl. (1882) pp. 47–81 (2 pls.). See Bot. Centralbl., xii. (1882) p. 33.

the Hammarby lake and neighbouring rocks at Danviken near Stockholm, of which several species and varieties are new. He gives also general critical remarks on the families named above.

The genus *Scenedesmus* is divided into two sections, the first of which belongs to the true Pediastreæ, while the second is nearly allied to some species of Palmellaceæ, as *Raphidium* and *Selenastrum*. The following are given as their characters:—Sect. I. *Obtusi*. Cellulæ utroque polo plerumque obtusæ vel rotundatæ. Cœnobium filiale ruptura membranæ cellulæ matricali liberum fit. Membrana cellularum adultarum, cum membrana specierum Sectionis II. comparata, subcrassa. *S. bijugatus*, *radiatus*, *alternans*, *denticulatus* n. sp., *aculeolatus*, *Hystrix* n. sp., *dispar*, and *quadricauda*. Sect. II. *Acuti*. Cellulæ utroque polo plerumque plus minusve acutæ. Propagatio incerta. Membrana cellularum adultarum cum membrana specierum Sectionis I. comparata, tenuis. *S. attenuatus* and *obliquus*.

The diagnosis follows of *Actinastrum*, a new genus of Palmellaceæ:—Cellulæ fusiformes, rarius fere obclavatæ vel cylindricæ, a centro communi radiatim exeuntes, familias quadricellulares vel octocellulares, libere natantes, formantes. Propagatio divisione succedanea cytioplasmatis cellularum fit, et familia filialis eo modo formata ruptura membranæ cellulæ matricalis libera fit. Zoosporæ ignotæ. Only species *A. Hantzschii*; long. cell, 10–24 μ; crass. 3–6 μ.

The previously unknown mode of reproduction of *Selenastrum* is thus described. In *S. acuminatum* n. sp. the cell-contents first divide lengthwise into two halves, the two daughter-cells again dividing by an oblique wall. These four cells sometimes directly constitute themselves into a new cœnobium, but usually only after another division, in which case either the whole eight cells may form a new cœnobium after the bursting of the membrane of the mother-cell, or they may constitute two cœnobia of four cells each. *Selenastrum* forms a connecting link between the Pediastreæ and Palmellaceæ.

In *Urococcus insignis* Kütz., (*Chroococcus macrococcus*) *β ferrugineus* Lagerh., neither the stipes nor all the integuments of the cell are coloured blue by chlor-iodide of zinc, but usually only the innermost of the latter.

The formation of new cœnobia of *Dictyosphærium reniforme* takes place by each mother-cell dividing by repeated bipartition into eight daughter-cells, all the membranes of the original cœnobium and of the stipites being absorbed. In *D. Ehrenbergianum* and *pulchellum*, on the contrary, the mother-cells only divide into four daughter-cells arranged in a cross, which then separate, and finally form new cœnobia by repeated bipartition.

Crenothrix Kühniana as a Contaminator of Water.* — The water which supplies Lille, from the springs at Emmerin, having become undrinkable in consequence of a red deposit and fœtid taste and smell, was found by A. Giard to be infected with *Crenothrix Kühniana*, which precipitates oxide of iron from aerated water. He found the microgonidia formed by transverse division in the sporangia

* Comptes Rendus, xiv. (1882) p. 247.

or terminal swellings of the filaments to be endowed with active movement by means of a cilium. From the gonidia was developed an irregular merismopodia-form, which soon passed into a zooglœa-like mass, and finally into regular cylindrical tubes of different lengths. The palmella-form described by Zopf he regards as a different organism belonging to *Ascococcus*. The only remedy he believes to be filtering; but recommends that the water for the supply of large towns should be obtained from deeper sources, and from springs free of salts of ferrous oxide and far removed from industrial establishments.

Alga parasitic on a Snake.*—P. Magnus describes, under the name *Cladophora* (*Spongomorpha*) *ophiophila*, a fresh-water alga found on the Siamese fresh-water snake, *Herpeton tentaculatum*. The dark-green plant branches profusely, three branches nearly in one plane springing from each node. From the lower cells of the main stem and of the lower branches spring unicellular fibres, which serve as organs of attachment, and enable the plant to resist the water through which the snake swims. Associated with the *Cladophora* is a characteristic vegetation consisting of a number of diatoms, a *Chamæsiphon* and a *Ulothrix*.

Structure of Diatoms.†—M. W. Prinz replies to the objections made by Mr. Deby, Count Castracane, and Prof. A. Grunow (Vol. I. (1881) pp. 508 and 509, and II. (1882) p. 246), to his view of the perforation of the valves of the species of diatoms examined by him in thin rock sections.

He considers that his objectors have drawn their principal arguments from facts observed in different conditions and from the examination of species different from those which he described. He agrees, however, that there are many species which present details of structure which teach nothing in regard to the conformation of other species of similar appearance.

The details of the structure of *Pleurosigma angulatum*, for instance, are too complicated and delicate to decide the question. The thinnest sections of this species always comprise at least two rows of pearls or pores. The siliceous membranes which contain these details will give in section the image of two continuous lines, one inner and the other outer. It is this which causes Dr. L. Flögel ‡ to maintain the existence of chambers closed by these membranes. This image is produced with all the sections, even those of the large species; but this aspect disappears when the section is sufficiently thin and it is examined by high powers. We then see that the black lines representing the membranes are discontinuous, and cut by bright lines which correspond to the openings. To study these details the thinness of the section must have relation to the fineness of the markings to be resolved. The greater part of the beautiful work of Dr. Flögel has been put in doubt by the observations of Müller,§ who has shown

* SB. Ges. naturf. Freunde Berlin, June 20, 1882. See Bot. Centralbl., xii. (1882) p. 75.

† Bull. Soc. Belg. Micr., ix. (1882) pp. 23–7.

‡ Arch. f. Mikr. Anat., vi. (1870) p. 472.

§ Bot. Ztg., 1872, p. 242.

that the sections of the former were too thick, and that the closed chambers which he described must be open, as they were filled up by the immersion in balsam. Müller, however, only admits an aperture on the outer side.

Impressions on collodion do not appear to have given the results expected by the authors who employed it. On the other hand, the submersion of the valves has equally furnished facts which are wanting in concordance.

Photographs, again, give only illusory diffraction images, and the suggested examination of the valves by reflected light cannot eliminate these errors.

To show the difficulty of these investigations it is sufficient to recall the fact that the parts which are much less delicate, such as the connective, the raphe, and the nodules, still give rise to very diverse interpretations. M. Prinz thinks that these divergences originate in great part from the want of distinctness in the sections obtained by cutting diatoms contained in a medium without consistency, such as gum arabic.

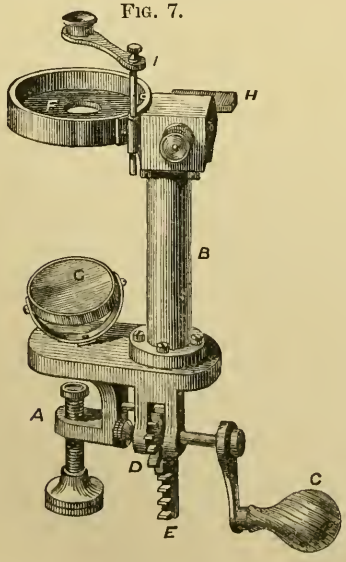
The author is about to re-examine some diatomiferous rocks with the assistance of Dr. Van Ermengem.

MICROSCOPY.

a. Instruments, Accessories, &c.

Boecker's Air-pump Microscope.—E. Boecker, of Wetzlar, manufactures the air-pump Microscope shown in Fig. 7, which enables an object to be examined in a vacuum under the Microscope, and the progressive effects attendant upon the exhaustion of the air watched, as well as serving for the more ordinary purposes of an air-pump in mounting.

Fig. 7.

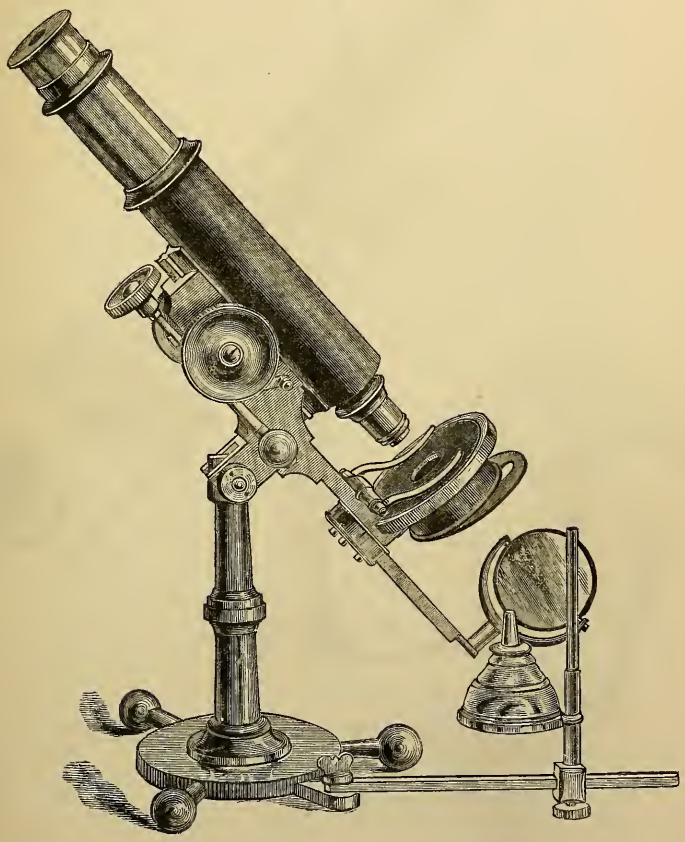


The apparatus is secured to the table by the clamp A, and the piston of the pump B is put in operation by the handle C acting on a rack and pinion D E. The chamber F ($2\frac{3}{4} \times \frac{3}{8}$ in. deep), in communication with the pump, is pierced with a central aperture which is closed by a piece of glass, allowing the light from the mirror G to reach the object placed in the chamber. The latter is made air-tight by a circular glass plate greased at its margin. H is the tap for readmitting the air. Either a simple or a compound Microscope can be attached

to the arm I, and the object observed while the chamber in which it is placed is being exhausted.*

Improved Griffith Club Microscope.† — The original "Griffith Club Microscope" was described in Vol. I. (1881) p. 293. Since that time important changes have been made by Mr. E. H. Griffith, so that very little of the original form is left, as will be seen on comparing figs. 8 and 9 with the earlier illustrations. It retains its original

Fig. 8.



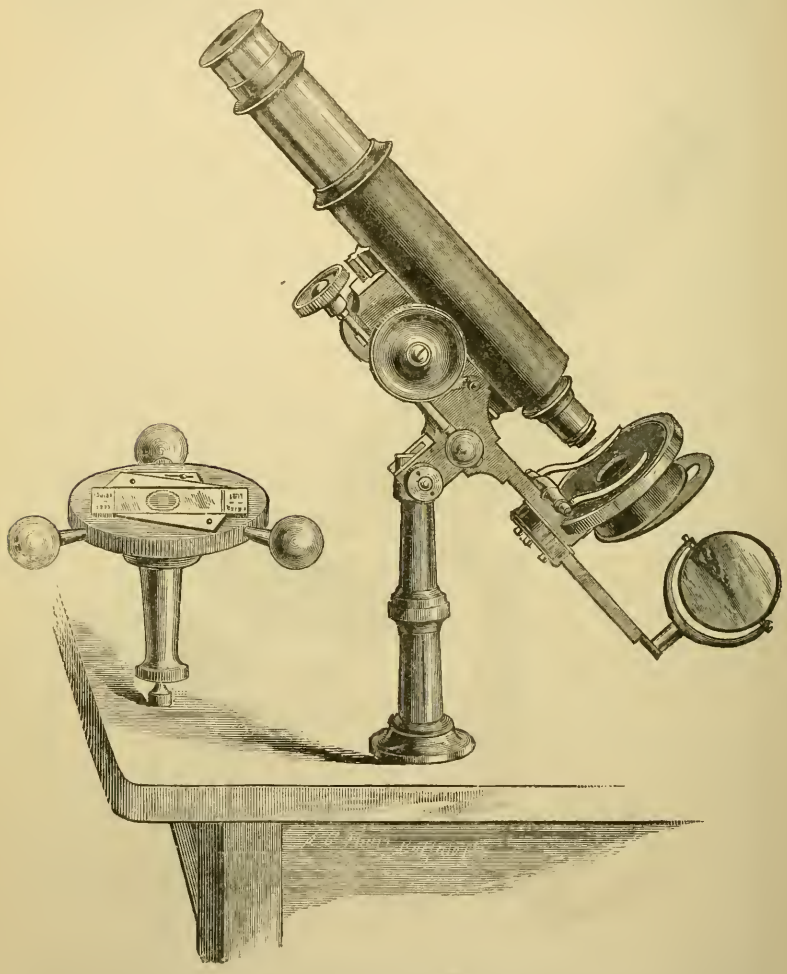
name in appreciation of the honour conferred on the inventor by the "Griffith" Clubs of Detroit and Danville, U.S.A. It is a full-sized

* Since the above was in type we observe that a nearly identical instrument is described by Dr. L. Dippel (in 'Das Mikroskop,' 2nd ed. 1882, p. 685, fig. 496) as made by Zeiss.

† Proc. Amer. Soc. Micr., 5th Annual Meeting, 1882, pp. 149–52 (3 figs.).

instrument and the main and draw tubes have the Society screw. The coarse adjustment is effected by rack and pinion on the "Jackson" principle, and has about 3 in. of motion. The fine adjustment, which appears to be both simple and efficient, is effected

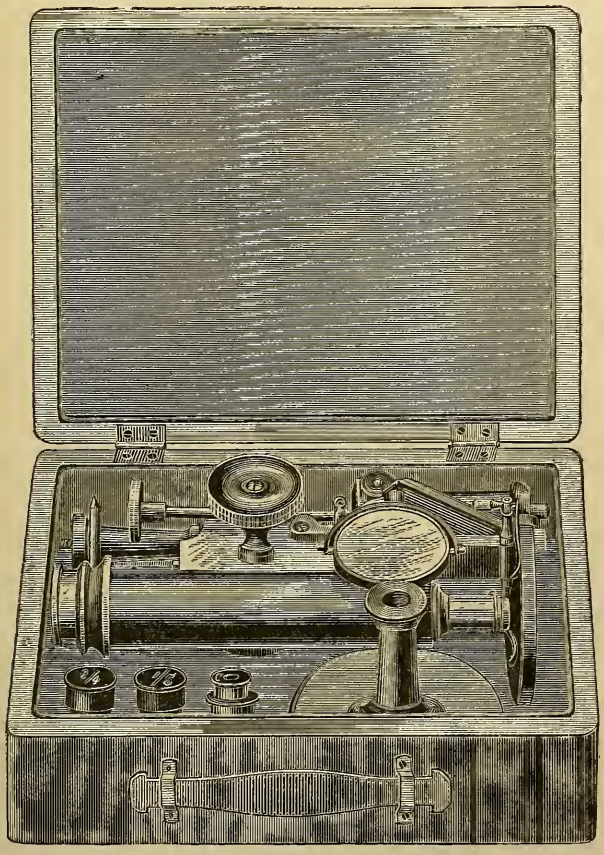
Fig. 9.



by the application of a worm-wheel and tangent-screw to the axis of the pinion of the coarse adjustment. The worm-wheel is on this axis, near the limb, and it is acted upon by the tangent-screw being sprung against it, the milled head of which is shown behind the limb in fig. 8. When the coarse adjustment is in use, a "snail"-shaped

lever on the right of the limb (handle shown beneath the large milled head) forces the tangent-screw from contact with the worm-wheel, a spring latchet locking it in position. By releasing the "snail" lever the tangent-screw is pressed into the worm-wheel, and acts upon the coarse adjustment so slowly that objectives of high power can be focussed with it. It will of course be understood that when the

Fig. 10.

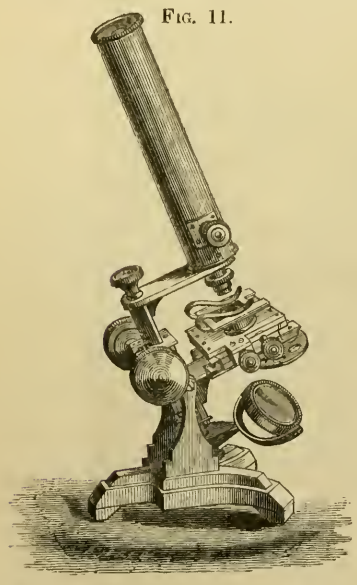


tangent-screw is sprung against the worm-wheel the coarse adjustment is no longer operative, which Mr. Griffith considers to be a protection against breakage of slides. A similar system of fine focussing was adopted in England many years ago, and is still used in some of Plössl's models. The stage clips are supported on a bar above the stage, allowing the slide to make almost a complete revolution. The

mirror-bar is adjustable in length, and the mirror can be set at any angle above or below the stage, allowing any obliquity of illumination for opaque and for transparent objects. The standard divides midway between the body and the foot, and the base may be detached, and the body set on an extra standard (fig. 9), with a screw at the end for fixing it in a tree, laboratory table, &c. The base being inverted and placed on a spindle, which is always in position in the box, becomes a turntable, provided with self-adjusting clips for holding the slide. Three rods, with silvered balls at one end, are the supports for the Microscope, and they give momentum to the turntable when in use. Two small holes in the edge of the turntable foot allow the attachment of an adjustable lamp-holder, which is furnished with a lamp for class, lecture, and exhibition use. A case about $7\frac{1}{2}$ in. long, $5\frac{1}{2}$ in. wide, and 3 in. deep, internal measure, holds the instrument when packed (fig. 10), and it may be taken down and packed for travelling or be taken from the box and set up ready for use in a few seconds, "making the Microscope not only a first-class monocular for home and office use, but also for the tourist and the naturalist." The Bausch and Lomb Optical Company are the makers.

"Midget" Microscope.—Owing to a misunderstanding the accompanying woodcut (fig. 11) of this Microscope was not given with its description at p. 852 of Vol. II. (1882), only the outline drawing to scale appearing with fig. 156 for comparison.

Fig. 11.



Microscopes for the Examination of Divided Circles.*—A somewhat novel application of Microscopes is seen in Wanschaff's apparatus for examining divided circles (fig. 12). The various parts of the base of the instrument are indicated by the letters *a*, *b*, *c*, *d*, and *e*, but these do not require notice here.

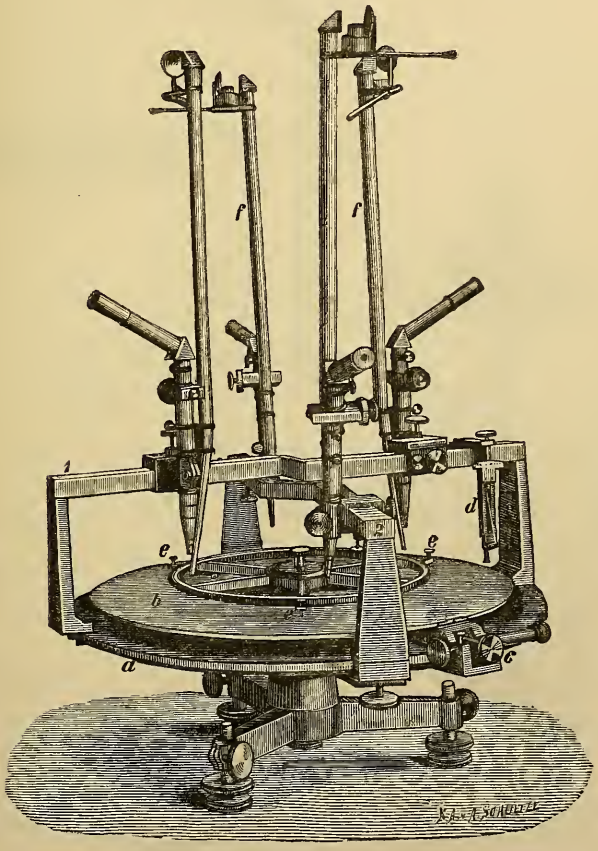
The lower fixed disk has two arms, upon which are adjusted four Microscopes intended to be directed upon the divisions of the circle under examination. The body-tube in all is, for greater convenience, bent outwards, with a prism at the angle. The power is about 60. The arm 1 is immovable, whilst 2, with its supports, can be revolved, so that the Microscopes on the two arms respectively can be placed at any desired

* Bericht über die wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg), pp. 74-6 (1 fig.).

angle to each other. In order that they may be brought quite close together, those on the arm 1 are fixed perpendicularly to the plane of the disk, while those on 2 are inclined outward, so that the same division can be observed through two Microscopes.

The illumination of the circle is effected through four tubes *f*

Fig. 12.



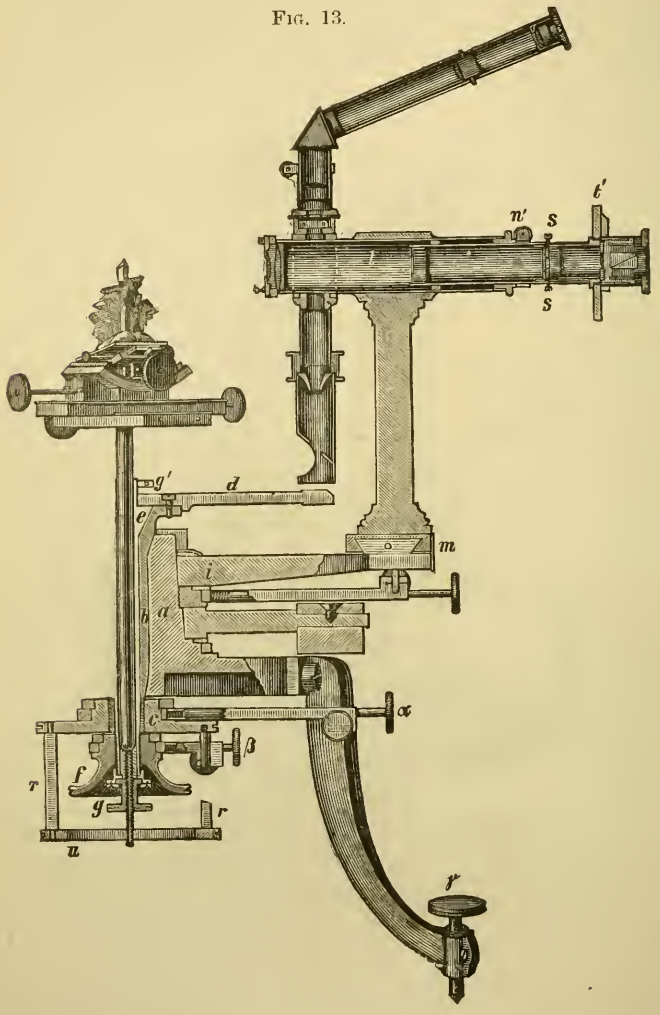
attached to the Microscopes, through which by means of concave mirrors and reflecting prisms, the light from four lamps is conducted down on the part of the circle to be examined.

Prof. W. A. Rogers, it will be remembered, uses for the same purpose the arrangement devised by Mr. Tolles, in which a prism is inserted between the lenses of the objective.* This would appear to be more convenient on the whole.

* Cf. this Journal, iii. (1880) p. 754.

In Fuess's Reflecting Goniometer* (fig. 13) two Microscopes are also arranged in a somewhat peculiar manner for reading off the

Fig. 13.



divisions on the divided circle. One passes through the telescope and the other through the collimator of the instrument, as shown in the figure.†

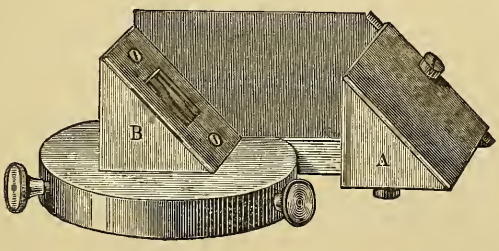
* Bericht über die wiss. Instrumente auf der Berliner Gewerbeausstellung im Jahre 1879 (L. Loewenberg), pp. 321–30 (4 figs.).

† The left (similar) half of the woodcut has been removed. The lettering refers to the parts of the instrument other than the Microscope.

Abbe's Camera Lucida.*—Dr. L. Dippel describes an addition to this apparatus† by which drawing with high powers is much facilitated. Between the prism and the mirror are interposed two movable glass plates of different tints, which can be used together or separately and serve to equalize the illumination of the field and the paper. Dr. Dippel adds, "so far as my experiments go the modified instrument surpasses all drawing instruments known to me in so high a degree that it must come into very general use."

Cameræ Lucidæ of Nobert and of Doyère and Milne-Edwards.‡—We describe and illustrate these forms more as a "contribution to the history of the camera lucida" than as offering any novelty at the present day. In the form introduced by Nobert (fig. 14)

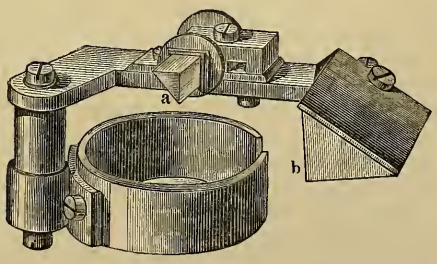
Fig. 14.



A is a rectangular prism and B a glass plate above the eye-piece, inclined at an angle of 45°, and composed of thin glass to avoid double reflection. The arrangement is, however, of little use with high eye-pieces.

The camera lucida of Doyère and Milne-Edwards (fig. 15) is

Fig. 15.



included in the catalogues of most German opticians at the present time, and has the advantage that it can be used with a high magnifying power and with the strongest eye-pieces. Dr. L. Dippel certifies that he has used it "almost exclusively for years, and can

* Bot. Centralbl., xii. (1882) pp. 211–2.

† See this Journal, ii. (1882) p. 261.

‡ Dippel, L., 'Das Mikroskop und seine Anwendung,' 1867, pp. 232–3 (2 figs.).

recommend it with perfect confidence as one of the most efficacious forms of drawing apparatus."

It consists of two rectangular prisms, of which the smaller *a* is placed over the eye-piece, while the larger *b* receives the reflection of the drawing pencil. As the prism over the eye-piece is very small, the observer can look past it at the image of the object in the Microscope, whilst the paper and the point of the pencil appear projected above it.

Grunow's Camera Lucida.*—This is a modification of the Abbe instrument, the mirror being replaced by a rectangular prism as in the Nobert and other forms.

Objectives of Large Aperture.†—Dr. J. Pelletan criticizes Dr. Carpenter's remarks on this subject at Montreal,‡ and in regard to injury to the eyesight suggested as the result of the use of a 4-10ths in. of large aperture, considers it an "accusation as well founded as to say that too large a hat will produce corns on the feet." If it is the fact that certain objectives may injure the sight it is the high powers with small angle, deficient in light, resolving badly, and requiring "efforts of vision," so to say, rather than the relatively low powers of large angle, bright, and showing at once the image of the object clearly resolved.

He also claims as conclusive evidence in favour of the necessity of objectives of the largest aperture the admission of Dr. Carpenter that the flagella of *Bacterium termo* could not have been discovered without such objectives. The ½-in. of 40° could not be of any use to a microscopist for delicate and serious observations, neither to the diatomist nor to the investigator of the histological elements who requires a large aperture to enable him to follow a fibril layer by layer so as to determine all the relations of its position and the precise point where it ends.

Abbe's Method of Testing Objectives.—The late Dr. H. E. Fripp published, in 1877,§ an account of Prof. Abbe's method of testing the optical quality of objectives, which he suggested might be usefully transferred to the pages of this Journal. Various causes have hitherto prevented this, but we are now able to print it:—

In ordinary practice, microscope objectives, if tested at all by their possessors, are simply subjected to a comparison of performance with other lenses tried upon the same "test objects." The relative excellence of the image seen through each lens may, however, depend in a great part upon fortunate illumination, and not a little upon the experience and manipulative skill of the observer; besides which any trustworthy estimate of the performance of the lens under examination involves the consideration of a suitable test object, as well as the magnifying power and aperture of the objective. The structure of the test object should be well known, and the value of its "markings,"

* Amer. Mon. Micr. Journ., iii. (1882) p. 201 (1 fig).
† Journ. de Microgr., vi. (1882) pp. 543–4.
‡ See this Journal, ii. (1882) pp. 698 and 854.
§ Proc. Bristol Naturalists' Soc., ii. (1876–9) pp. 3–11 (2 figs.).

if intended to indicate microscopical dimensions, should be accurately ascertained, care being taken that the minuteness of dimensions and general delicacy and perfection of the test object should be adapted to the power of the lens. A fairly correct estimate of the *relative* performance of lenses of moderate magnifying power may doubtless be thus made by a competent observer, but it is not possible from any comparisons of this kind to determine what may or ought to be the ultimate limit of optical performance, or whether any particular lens under examination has actually reached this limit.

Assuming the manipulation of the instrument and the illumination of the object to be as perfect as possible, and, further, that the test-object has been selected with due appreciation of the requirements of perfect optical delineation, a fair comparison can only be drawn between objectives of the same magnifying power and aperture. Which of two or more objectives gives the better image may be readily enough ascertained by such comparison, but the values thus ascertained hold good only for the particular class of objects examined. The best performance realized with a given magnifying power may possibly exceed expectation, yet still be below what might, and therefore ought to be obtained. On the other hand, extravagant expectations may induce a belief in performances which cannot be realized. The employment of the test objects most in use is, moreover, calculated to lead to an entirely one-sided estimation of the actual working power of an objective, as, for example, when "resolving power" is estimated by its *extreme limits* rather than by its general efficiency; or "defining power," by extent of amplification rather than by clearness of outline. So that an observer is tempted to affirm that he can discern through his pet lens what no eye can see or lens show. This happens chiefly with the inexperienced beginner, but not unfrequently also with the advocate of extremely high powers, in whose mind separation of detail means analysis of structure, and optically void interspaces prove the non-existence of anything which he does not see.

As much time is often lost by frequent repetition of these competitive examinations (which after all lead to no better result than that the observer finds or fancies that one lens performs in his hands more or less satisfactorily than some other lens), it seems worth while to invite attention to a mode of testing which can be readily practised by any person, with a fair certainty of being able to form a really correct estimate of the working capacity of his instrument, measuring this by a standard of strict optical requirements. The advantage of substituting some such proceeding for the comparative trial of lens against lens, so long in vogue, can scarcely be disputed. For, although the best warrant of a well-constructed lens is the fair reputation of its maker, and the choice of an objective resolves itself for the most part into the selection of the particular make of one or other of the best accredited opticians, still, when the instrument is purchased, its possessor frequently becomes haunted by the desire to pit its performance against that of some neighbour's instrument, or to match the performances traditionally accepted in our handbooks. A short and easy method of testing an objective, not by comparison with

others only, but by itself and on its own merits, affords not only the most direct and positive evidence of its qualities to those who are more concerned in proving their instruments than using them, but also yields to the genuine worker the satisfying conviction that his labour is not frustrated by faulty construction and performance of his instrument. It is, however, to be borne in mind that the microscopist, in any scrutiny of the quality of his lenses which he may attempt, has no other object in view than to acquire such insight into the optical conditions of good performance as will enable him to make the best use of his instrument, and acquire confidence in his interpretation of what he sees, as well as manipulative skill in examining microscopical objects. To the constructor and expert of optical science are left the severer investigations of optical effects and causes, the difficulties of technical construction, the invention of new lens-combinations, and the numerous methods of testing their labours by delicate and exhaustive processes which require special aptitude, and lie entirely outside the sphere of the microscopist's usual work.

The mode of testing the optical power of an objective here described, is that devised by Prof. Abbe, and explained in his 'Beiträge zur Theorie des Mikroskops.' *

The process is based on the following principle:—

In any combination of lenses of which an objective is composed, the geometrical delineations of the image of any object will be more or less complete and accurate according as the pencils of light coming from the object are more or less perfectly focussed on the conjugate focal plane of the objective. On this depend fine definition and exact distribution of light and shade. The accuracy of this focussing function will be best ascertained by analysing the course of isolated pencils directed upon different parts, or zones, of the aperture, and observing the union of the several images in the focal plane. For this purpose it is necessary to bring under view the collective action of each part of the aperture, central or peripheral, while at the same time the image, which each part singly and separately forms, must be distinguishable and capable of comparison with the other images.

1. The illumination must therefore be so regulated that each zone of the aperture shall be represented by an image formed in the upper focal plane of the objective (i. e. close behind or above its back lens), so that only one narrow track of light be allowed to pass for each zone, the tracts representing the several zones being kept as far as possible apart from each other.

Thus supposing the working surface of the front lens of an objective to be 1-4th in. in diameter, the image of the pencil of light let in should not occupy a larger space than 1-16th in. When two pencils are employed, one of these should fall so as to extend from the centre of the field to 1-16th in. outside of it, and the other should fall on the opposite side of the axis, in the outer periphery of the field, leaving thus a space of 1-16th in. clear between its own inner margin and the centre of the field, as in fig. 16, where the objective images of the pencils occupy each a quarter of the diameter of the whole field.

* Arch. f. Mikr. Anat., ix. (1873) p. 413.

If *three* pencils of light be employed, the first should fall so as to extend from the centre of the field to 1-25th in. outside of it; the second should occupy a zone on the opposite side of it, between the 1-25th and 1-12th in. (measured from the centre), and the third, the peripheral zone on the same side as the first, as in fig. 17.

This arrangement places the pencils of light in their most sensitive position, and exposes most vividly any existing defect in correction, since the course of the rays is such that the pencils meet in the focal plane of the image at the widest possible angle. As many distinct images will be perceived as there may be zones or portions of the front face of the objective put in operation by separate pencils of light. If the objective be perfect all these images should blend *with one setting of focus* into a single clear colourless picture. Such a fusion of images into one, is, however, prevented by faults of the image-forming process, which, so far as they arise from spherical aberration, do not allow this coincidence of several images from different parts of the field to take place at the same time, and so far as they arise from dispersion of colour, produce coloured fringes on the edges bordering the dark and light lines of the test object, and the edges of each separate image, as also of the corresponding coincident images in other parts of the field. It is to be borne in mind that the errors which are apparent with two or three such pencils of light, must necessarily be multiplied when the *whole area* of an objective of faulty construction is in action.

Fig. 16.

Fig. 17.

2. *The means by which such isolated pencils can be obtained.*

If a special illuminating apparatus be employed, the condenser of Professor Abbe will be found very convenient, but almost any condenser of the kind (hemispherical lens) may be arranged for this purpose.

In the lower focal plane of the illuminating lens must be fitted diaphragms (easily made of blackened cardboard) pierced with two or three openings of such a size that their images, as formed by the objective, may occupy a fourth or sixth part of the diameter of the whole aperture (i. e. of the field seen when looking down the tube of the instrument, after removing the ocular, upon the objective image). The required size of these holes, which depends, firstly on the focal length of the illuminating lens, and secondly, on the aperture of the objective, may be thus found. A test object being first sharply focussed, card diaphragms having holes of various sizes (two or three of the same size in each card) must be tried until one size is found, the image of which in the posterior focal plane of the objective shall be about a fourth to a sixth part of the diameter of the field of the objective. Holes having the dimensions thus experimentally found to give the required size of image must then be pierced in a card, in such position as will produce images situate in the field as shown by figs. 16 and 17, and the card is then fixed in its place below the condenser. If the condenser be fitted so as to revolve round the axis of the instrument and also carry with it

the ring or tube to which the card diaphragm is fixed, the pencils of light admitted through the holes, will, by simply turning the condenser round, sweep the face of the lens in as many zones as there are holes. Supposing the condenser to be carried on a rotating substage, no additional arrangement is required besides the diaphragm carrier. Thus, for example, if a Collins' condenser fitting in a rotating substage be used, all that is required is to substitute for the diaphragm which carries the stops and apertures as arranged by the maker, a diaphragm pierced with say three openings of 3-4ths in. diameter, in which circles of card may be dropped, the card being pierced with holes of different sizes according to the directions given above.

Another plan adopted by Dr. Fripp and found very convenient in practice is to mount a condensing lens (Professor Abbe's in this case) upon a short piece of tube which fits in the rotating substage. On opposite sides of this tube, and at a distance from the lower lens equal to the focal distance of the combinations, slits are cut out, through which a slip of stout cardboard can be passed across and below the lens. In the cardboard, holes of various sizes, and at various distances from each other, may be pierced according to pleasure. By simply passing the slip through the tube, the pencils of light admitted through the holes (which form images of these holes in the upper focal plane of the objective) are made to traverse the field of view, and by rotating the substage the whole face of the lens is swept and thus searched in any direction required.

When an instrument is not provided with a rotating substage it is sufficient to mount the condenser on a piece of tubing, which may slide in the setting always provided for the diaphragm on the under side of the stage. Card diaphragms for experiment may be placed upon the top of a third piece of tube (open at both ends) made to slide inside that which carries the condenser, and removable at will. By rotating this inner tube the pencils of light will be made to sweep round in the field, and thus permit each part of the central or peripheral zones to be brought into play.

3. *Test object.*

For this a prepared plate is required which shall present sharply defined black and white stripes, opaque and clear lines alternating at close intervals, and lying absolutely in the same plane, so that no deviation can occur in the course of pencils of light transmitted through it. A test plate sufficiently perfect for all practical purposes may be made by ruling groups of lines, coarse and fine, with the aid of a dividing machine on a metallic film of silver or gold of infinite thinness, and fixed by known methods on glass. Cover-glasses of various thicknesses, from 0·24 mm. to 0·09 mm. (accurately measured), are ruled on one surface thus coated with a film of metal, the groups of lines varying from 1-250th to 1-1250th in.; the ruled side is then cemented with balsam on a polished glass slip, several such prepared glasses being cemented side by side on the same slip, presenting the appearance shown in fig. 18 (natural size), fig. 19 being one of the circles enlarged.

A perfectly corrected objective, tested with the test object, and by

the mode of illumination above described, ought to show over the middle of the field a clearly defined image of the groups of lines under examination *without any alteration of focus*, and the coloured

Fig. 18.

borders of the separate partial images should not show any other tints than a very narrow edging of pure green, rose, or violet of the secondary colours of a spectrum. Spherical aberration is revealed, when, with the best focussing, the clear lines appear as if immersed in the middle of a broader foggy streak, or when two images, more or less overlapping each other, merge on altering the focus, into one image, somewhat broader and more misty.

Fig. 19.

A short and ready method of testing approximately any objective is recommended by Professor Abbe, as it is applicable to all instruments without requiring any apparatus except the test object already described. This may be briefly explained as follows :—

First, focus the test plate with central illuminating rays, then withdraw the eye-piece, and turn aside the mirror so as to give the utmost obliquity of illumination, which the objective under trial will admit of. This will be best determined by looking down the tube of the Microscope whilst moving the mirror, and observing when the elliptic image of light reflected from it, reaches the peripheral edge of the field. As soon as this is done, replace the eye-piece, and examine afresh the object plate *without altering the focus*. If the objective be perfectly corrected, the groups of lines will be seen with as sharply defined edges as before, and the colours of the edges must, as before, appear only as those of the secondary spectrum in narrow and pure outline. Defective correction is revealed when this sharp definition fails, and the lines appear misty and overspread with colour, or when *an alteration of focus* is necessary to get better definition, and colours confuse the images.

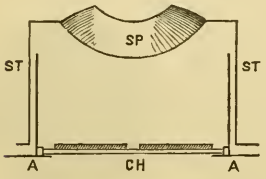
A test image of this kind at once lays bare in all particulars the whole state of correction of the Microscope; it being of course assumed that the observer knows how to observe and what to look for.

With the aid which theory offers to the diagnosis of the various

aberrations, a comparison of the coloured borders of the separate partial images, and an examination of their lateral separation and their differences of level, as well in the middle as in the peripheral zones of the entire field, suffices for an accurate definition of the nature and amount of the several errors of correction, each of them appearing in its own primary form. Therewith we also see that which arises from aberration, properly so called (faults of focussing function), clearly separated from such imperfections or anomalies as spring from mere differences of amplification between unequally converged and unequally refracted rays; and moreover we eliminate completely all influence of the ocular on the quality of the image.

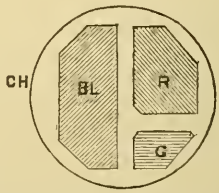
Hardy's Chromatoscope.—Mr. J. D. Hardy describes a method of illumination by an instrument (figs. 20 and 21) which he calls the "Chromatoscope":—"Its chief purpose is that of illuminating and defining objects which are non-polarizable, in a similar manner to that in which the polariscope defines polarizable objects. It can also be

Fig. 20.



Sp. Spot lens in its tube *St.* *Ch.* Chromatoscope glass plate resting on the inner flange of the tube *A*.

Fig. 21.



The letters indicate the disposition of the blue, red, and green stained glass.

applied to many polarizable objects. This quality, combined with the transmission of a greater amount of light than is obtainable by the polariscope, renders objects thus seen much more effective.

It is constructed as follows:—Into the tube of the spot lens (fig. 20) a short tube is made to move freely and easily. This inner tube has a double flange, the outer one (which is milled) for rotating, and the inner one for carrying a glass plate. This plate (fig. 21) is made of flat, clear glass, and upon it are cemented by a very small quantity of balsam, three pieces of coloured (stained) glass, blue, red, and green, in the proportion of about 8, 5, and 3, as shown in the figure. The light from the lamp is allowed to pass to some extent through the interspaces, and is by comparison a strong yellow, thus giving four principal colours. Secondary colours are formed by a combination of the rays in passing through the spot lens. The stained glass should be as rich in colour and as good in quality as possible, and a better effect is obtained by three pieces of stained glass than by a number of small pieces.

The application of the chromatoscope is almost unlimited, as it can be used with all objectives up to the 1-8th. Transparent objects,

particularly crystals which will not polarize, diatoms, infusoria, palates of molluscs, &c., can not only be seen to greater advantage, but their parts can be more easily studied. As its cost is merely nominal, it can be applied to every instrument, large or small, and when its merits and its utility by practice are known, I am confident that it will be considered a valuable accessory to the Microscope."

Gundlach's Substage Refractor.—E. Gundlach publishes directions (with a table) for using this apparatus for the determination of the aperture of objectives from 1·13 N.A. to 1·51 N.A. (97° to 180° in crown glass).

The refractor (described Vol. II. (1882) pp. 692 and 860) consists of a small cube of glass, having one blackened and several polished surfaces.

To use it, screw on the objective, and in place of the eye-piece, put a diaphragm having an opening about 1-4th in. in diameter. Then to the front surface of the objective, with a very small drop of Canada balsam, make the refractor adhere by that surface which is opposite the blackened one, in such a position that the two polished side surfaces will stand vertical when the body is brought into a horizontal position. Let the balsam harden a little; place the body in a horizontal position, and turn the mirror to one side to get it out of the way.

Then place two lights—flat-wicked oil lamps are best—at some distance from the Microscope, say six or eight feet, one on each side of the optical axis, and at first pretty near this axis. By looking through the diaphragm at the eye-piece end, towards the objective, the two lights will appear there as two small light-spots, presuming the angle of the objective to be large enough. If they do not appear, and also will not, or at least one of them, when the lights are brought very near together, then the angle of the objective is smaller than 96° or 97° in crown glass, according to the index of refraction of the crown glass used in the refractor; and the angle cannot be determined with it. If they appear, move both lights slowly away from the axis and find carefully the place for each where its image in the objective will just disappear. Determine the angle described by the light-rays entering the refractor at each side from each lamp, either by measuring directly, or by measuring the distance of the lamps from each other and from the refractor, reducing the distance of the lamps by the thickness of the glass cube, and finding from these three measurements, as the sides of a triangle, the desired angle by calculation.

Compare the angle thus found with those given in column A of the table, and find the one which is nearest to the determined angle. The corresponding angle of column B is the crown-glass angle of the objective, and the corresponding number of column C is its numerical aperture. The balsam may be removed easily and safely with a little benzine.

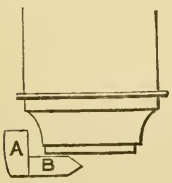
Tolles' Frontal-prism Illuminator.—Fig. 22 shows an arrangement devised by Mr. R. B. Tolles to be applied to the front of a 1-in. objective for illuminating opaque objects.

The segment of a plano-convex lens A has a curvature of 0·4 in. radius, and for convenience of mounting, the segment is somewhat longer than is optically necessary. To it is cemented an equilateral prism from which the greater portions of the basal angles have been cut off so as to leave only a small part of the original form of the prism at the apex B. The dimensions of the prism are:—

Total length	0·30 in.
Upper reflecting face	·11 „
Surface of emergence	·075 „
Thickness	·1 „
Breadth	·2 „

The lens condenses the rays upon the upper internal face of the prism, whence they are totally reflected and pass with slight refraction through the lower prism-face in the direction of an object placed under the centre of the front lens of the objective.

Fig. 22.



Mr. Tolles states that by this arrangement the effective aperture of the object is not reduced, as the apex of the prism is placed just outside the cone of rays which the objective transmits from the object.

Such a device seems hardly needed for so low a power as 1 in., but it would be interesting to know if the plan can be successfully used with higher powers.

Warm and Moist Stages.—Dr. R. L. Maddox describes several forms of these stages which he has devised.

A slab of ebonite $3\frac{1}{2} \times 2\frac{1}{4} \times \frac{3}{8}$ in. has a central hole 5-8ths in. in diameter, slightly countersunk on the under side (fig. 23), into

Fig. 23.

which is cemented a circle of stout cover-glass. On the upper side a deep groove is cut at about 1-12th in. from the aperture, 1-8th in. wide, and 3-16ths in. deep; another deep groove concentric with the former being turned out 1-12th in. from it, about 3-16ths in. wide and 5-16ths in. deep. Two holes are drilled through one end of the slab, $\frac{1}{2}$ in. apart, ending in the outer groove. At the opposite end of the slab either a deep well is sunk to hold a small circular thermometer, or a hole is drilled through the end of the slab reaching nearly to the outer groove, to hold a clinical thermometer. The opposite holes have two small brass tubes $1\frac{1}{2}$ in. long screwed into them and cemented air-tight. Three screws, furnished with rather wide thin screw nuts, are screwed into the base-plate, one between the

two drilled holes and 6-8ths in. from the edge of the base-plate, the two others at 6-8ths in. from the opposite end and 5-16ths from the sides; the screws project through the top of the plate about 3-16ths of an inch. This completes the base-plate.

The top-plate consists of a stiff thin plate of brass, $2\frac{3}{4}$ in. long by $2\frac{1}{4}$ in. wide, with a central aperture of $\frac{1}{2}$ in. countersunk or bevelled on one side, which forms the upper surface; three holes are drilled to permit the three screws to pass through, and if the circular thermometer be preferred a portion of the edge is cut away, half-moon shape, to permit of easy reading of the small thermometer. To the non-bevelled surface is cemented a thin circle 5-8ths in. wide; a plain ring of brass, which will drop easily into the middle of the inner groove flush with its upper surface, is soldered on to the under surface of the top-plate. This completes the top-plate, which should be platinum blacked.

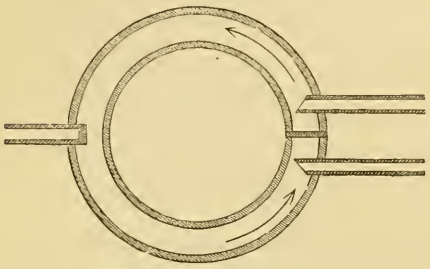
In use the top-plate is turned over, under surface up. On the thin cover is put the droplet, with the objects for study, and, if required, a very thin, small circle of mica or thin cover-glass is placed carefully upon it, which will adhere by capillary attraction. An indiarubber flat band, with an aperture that will just pass over the brass ring without undue stretching, is put on, the width of the band or a little sheet of pure indiarubber extending to the side edges of the top-plate. If the observation is likely to be carried on for any time, a little olive-oil or glycerine, or even water, is placed in the narrow groove, into which the ring fits easily. To the two tubes in the base-plate are attached two narrow indiarubber tubes about 8 in. long, into the opposite ends of which are fixed two glass tubes, drawn out at the free ends into almost capillary orifices. The cover ready prepared is now put on the base-plate, the brass ring dipping into the fluid in the inner groove forming an air-tight trap, the nuts are screwed on to the three screws and pressure made on the top-plate, so as to render, by means of the wide flat band of indiarubber, the whole water-tight. A piece of thick grey or drab cloth, with a central aperture 3-4ths in. or 1 in. in diameter punched out of the centre, is placed on the stage of the Microscope, and on it is arranged the warm stage. A vessel containing hot water is supported on a tripod at one side or in front of the Microscope; one of the tubes is put into it, reaching to the bottom; the end of the other tube is placed in the mouth and the water sucked through, and is then turned down into a vessel to receive the water that passes round the outer groove, the rate of discharge being in relation to the length of the lower limb of the siphon and the entering orifice for the flow of hot water, as in Professor E. H. Bartley's plan.* To ensure the water flowing round the groove, it is best to place a partition in the outer groove between the two drilled holes for the brass tubes. The water in the vessel may be maintained at any required heat up to the boiling-point by means of a lamp or gas flame, but if kept steadily at 160° Fahr. the thermometer indicates a temperature of about 92° Fahr. Should plenty of moisture be

* See this Journal, i. (1881) p. 672.

required, a narrow strip of blotting-paper can be damped and placed round the central hole, making it adhere to the sides.

Another form (fig. 24) consists of a hollow ring of brass, $1\frac{3}{4}$ in. external diameter, the tube of the ring being about 1-4th in. outside diameter. A saw-cut is made almost through the ring, and into it is soldered a partition plate. On each side, about 1-4th in. from the partition, two holes are drilled into the tube, and into each is soldered a fine brass tube; at the opposite side of the ring is soldered another tube, closed at the end that is fixed in the ring. Into this, when in use, is placed the end of a small clinical thermometer. Indiarubber tubes are attached to the two brass tubes, as in the former, terminating in glass tubes with small orifices.

Fig. 24.



Two flat plates of thin ebonite are also required, with central apertures of the same diameter as in the previous forms, the bottom one having its aperture closed with a stout cover circle, and the upper one with a thin cover circle cemented to the inner surface.

To use the ring-stage, place a narrow ring of damp blotting-paper on the upper surface of the bottom plate, then a flat ring of india-rubber; upon this carefully put the brass ring (which has its upper and under surface slightly flattened on the lathe), and on the top, place a similar indiarubber band; then, having put the material to be examined on the under surface of the thin cover, either protected with mica or otherwise, turn it over upon the indiarubber ring on the brass ring, and bind the two ebonite plates together by two stout indiarubber bands. This is then used in the same way as the former, the temperature obtained being very similar; the thermometer is placed at any part of the upper plate, but preferably on the part over or between the two brass tubes.

The brass portion of this form may be put to another use. To a thin ebonite plate with a central aperture (fig. 25) is cemented and

Fig. 25.

pinned a circular ebonite block of the same thickness as the ebonite stage of the first form. In the block is turned a central aperture wider at the base than at the top, which is slightly countersunk, and

into it is cemented a small cover circle; round the central aperture is turned concentrically a deep groove to form an air-space, and into which a moistening thread can be placed if required. A brass cap with milled edge and central aperture has cemented to the inside, over the aperture, a thin circle cover, and on this the object is to be placed. Over the outside of the circular ebonite block is slipped a thin, narrow indiarubber ring; the brass cap must fit correctly over the ebonite block, the ring of the cap closing upon the indiarubber ring, making the whole air-tight, and bringing the free surface of the droplet of liquid to touch the surface of the small glass circle, in a similar way to the ordinary live-box. The brass ring warm stage is now placed over the circular block of ebonite. In this way it is found, if care be taken, that the circular thermometer placed on the thin cover indicates 90° Fahr. without the water boiling, and if protected from cooling by cloth above and below, the temperature can be equably maintained.

Another plan is to employ two thin ebonite plates 3 by 1½ in., pierced with apertures about 5-8ths in. bevelled on one side; each is closed with a thin cover circle, one is used as the base-plate, the other as an ordinary slide. The object is put on the cover; upon this is gently placed a very thin cover-glass about 7-16ths in. in diameter; one or two small indiarubber bands are placed flat on the lower plate, the upper one is reversed over them, and the two are bound together by two indiarubber rings. An air-tight space is thus easily made, and if it be desired to add moisture, a thin circle of damp blotting-paper can be placed within the rings, or if between them, the edge of the ring of paper may project and be moistened as required; but the pressure from the bands must not be too great. If increased temperature be required, the whole can be put on the brass ring stage without trouble.

Dr. Maddox does not claim that there is much novelty in these different forms, but he believes they differ somewhat from any described, and may prove useful in the study of minute organisms, which has so largely developed within the last few years.

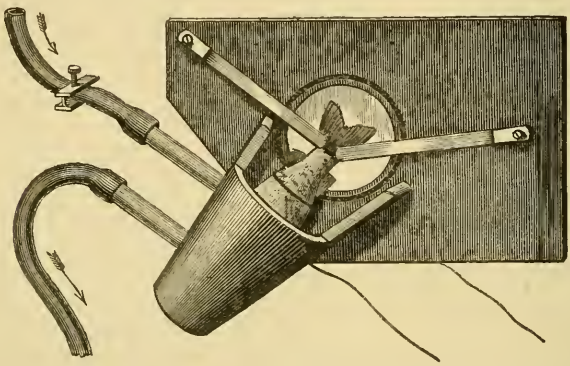
Dibdin's Hot Stage.*—Mr. W. J. Dibdin also describes a form of "Hot Stage" in which simplicity is probably carried to its furthest limit. It consists only of a square white glass bottle resting on the stage (which must be inclined 45°). In its cork is a thermometer and two siphon tubes, one serving as a waste-pipe and the other communicating (by a piece of indiarubber tubing) with another siphon-tube in the cork of a flask, which is kept heated on a tripod over a spirit-lamp, and also has a thermometer. A constant stream of water is thus kept flowing through the bottle on the upper side of which the object is placed. Mr. Dibdin used the apparatus for observing the bursting-point of starch cells.

Caton's Fish-trough. — This (fig. 26) consists of an oblong or slightly conical box of ebonite, closed at one end and large enough to hold the body of a minnow or stickleback very loosely. This box is attached to a plate of ebonite, which can be placed on the stage of the

* Journ. Post. Micr. Soc., i. (1882) pp. 177–8 (1 fig.).

Microscope. The tail of the fish covers an aperture in the plate closed with a piece of glass, and it is held securely in its place by a ligature; the caudal fin, which rests on the glass, is further secured by a couple of springs. The box itself, which incloses the head and

Fig. 26.



gills of the fish, contains water which is constantly renewed by means of two tubes, the upper of which, guarded by a screw-clamp, communicates with a vessel at a higher level, the lower conveying the water away as fast as it is supplied. The stage must be inclined at an angle of about 40°. "The excellency of this method" (according to Prof. J. Burdon-Sanderson *) "lies in the fact that the animal can be kept under observation, without the use of any narcotizing drug, for a long time in a perfectly natural condition."

Dayton's Modification of the Wenham Half-disk Illuminator.† Dr. R. Dayton, being convinced that the improved resolution of the markings upon diatoms, when the V-shaped diaphragm was used, consisted not so much in its cutting off the less oblique pencils of light reflected from the mirror, but in the total exclusion of the diffused rays emanating from the source of illumination, describes a modification by which the benefits arising from the use of the Wenham half-disk are combined with those of the Woodward prism and V diaphragm in a single apparatus.

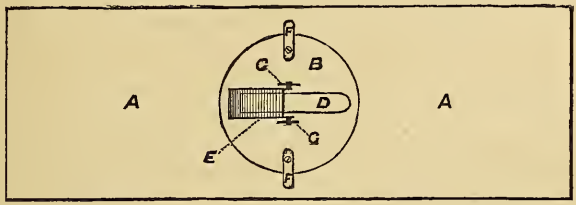
A brass slide, 3 in. by 1 in., A A (fig. 27, under-view; fig. 28, vertical section), has a circular bevelled opening, in which a correspondingly bevelled brass disk B fits from above. Two latchets F F are attached to the under surface of the disk, and allow it to rotate freely in its bed without slipping out of the slide. In the disk B is an opening exactly fitting the illuminator D. Dr. Dayton proposes to cut away a portion of the lenticular edge of the latter, leaving a

* 'Handbook for the Physiological Laboratory,' 1873, p. 229 (1 fig.). In the fig. the shape of the box differs slightly from that in our text.

† Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 161–3 (3 figs.).

plane face H (fig. 27) on one side, through which parallel rays making an angle of 68° with the optic axis may be transmitted without condensation, as in Woodward's prism. A swinging shutter-diaphragm E, of blackened brass, forming a shell-like quadrant exterior to the illuminator, is suspended on pivots G G (fig. 27) on either side of the

Fig. 27.



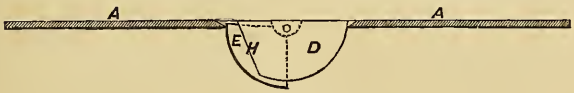


Fig. 28.

illuminator, so that it can be swung to shut off light from the plane or lenticular edge. The rotation of the disk B allows either edge of the glass disk D to be presented to the source of illumination. A slit-diaphragm cut through a very thin brass disk is placed on the upper surface of B, and completes the device.

No plan of mounting the semi-disk, or prism, or hemisphere, can, we think, be considered advantageous in which they are not left entirely free of the rectangular mechanical motions of the object-stage. As regards the use of a slit-diaphragm in connection with the swinging shutter, we possess a device, made seven years ago by Tolles, in which the slit is cut through the swinging shutter, which we think will be found the more convenient arrangement.

Adams, J. M.—The Microscope among Infinities.
[Speculations on the limits of perception.]
The Microscope, II. (1882) pp. 164–5.

" " How to turn over Small Objects.
["A simple and convenient way of turning over small objects, as corpuscles, epithelium, diatoms, &c., in a liquid, is to half fill a live-box and revolve the stage or hold the instrument so that it can be swayed out of level or from one side to another. In this way all sides can be easily and readily seen."]
The Microscope, II. (1882) p. 165.

Blackburn, W.—The Theory of Aperture in the Microscope: a popular exposition. *North. Microscopist*, II. (1882) pp. 325–34 (11 figs.).

Blackham, G.—Presidential Addresses at the Elmira Meeting of the American Society of Microscopists.
[The Evolution of the Modern Microscope, &c. Cf. Vol. II. (1882) p. 698. Appendix of leading facts in the lives of R. B. Tolles, E. Gundlach, W. H. Bulloch, and the Bausch and Lomb Optical Co.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 4–5, 5–8, 25–47.

Boecker, E.—See Dippel, L., *infra*.

Bradbury, W.—The Achromatic Object-glass, XIII., XIV.
Engl. Mech., XXXVI. (1882) pp. 351–2, 421–2.

Bradford, Microscopical Society for. *Micr. News*, III. (1883) p. 24.

Brittain, T.—The Beginnings of Microscopic Study in Manchester [from 183 –82.]
Field Natural., I. (1882) pp. 14?–50.

Carpenter, W. B.—On Angular Aperture in relation to Biological Investigation.
[Title only of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci. Same as II. (1882) p. 698.]
Amer. Natural., XVI. (1882) p. 1050.

" " Remarks made at the dinner of the New York Microscopical Society.
[Personal recollections of the first development of the achromatic Microscope in London.]
Amer. Mon. Micr. Journ., III. (1882) pp. 203–5, 219–20.

Crisp, F.—Notes sur l'Ouverture, la vision microscopique et la valeur des objectifs à immersion à grand angle. (Notes on Aperture, Microscopical Vision, and the value of wide-angled Immersion Objectives.)—*contd.*
[Transl. of paper, *ante*, I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 473–5.

Crumbaugh, J. W.—The History of the Microscope and its Accessories, IV.
The Microscope, II. (1882) p. 145–9.

Cuvillier, A.—Ein Mikrometer-Kaliber. (Micrometer-Callipers.)
[Allows of exact measurements to 0·01 mm. or 0·0004 in.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 260 (1 fig.), from *Scientific American*, 9th Sept. 1882.

Davies, A. E.—Microscopical.
[Commendation of Tolles' Amplifier, and suggestion that instead of being screwed into the draw-tube it should be fitted in a box and made to slip in and out like the prism in the Wenham binocular.]
Engl. Mech., XXXVI. (1882) p. 276.

Davis, G. E.—Dr. Carpenter in America.
[Criticism of remarks on the aperture of objectives at the meeting of the Amer. Assoc. Adv. Sci. at Montreal. Vol. II. (1882) pp. 698 & 854.]
Micr. News, III. (1882) pp. 15–18.

" " Preparing drawings for the *Microscopical News*.
[Deals with the value of Photo-zincography for illustrating microscopical literature, with directions for drawing.]
Micr. News, III. (1882) pp. 19–21 (1 fig.).

Dayton, R.—Modification of the Wenham Half-disk Illuminator with an improved Mounting. [*Supra*, p. 132.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 161–3 (3 figs.).

Deecke, T.—Brief Description of Large Microscope and Apparatus for Photographing large Sections. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 277–9.

Dibdin, W. J.—Hot Stage. [*Supra*, p. 131.]
Journ. Post. Micr. Soc., I. (1882) pp. 177–8 (1 fig.).

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" " Ein neuer beweglicher Objecttisch. (A new movable stage.)
[Devised by E. Boecker of Wetzlar. Does not appear to be specially novel.]
Bot. Centralbl., XII. (1882) pp. 385–6.

Fell, G. E.—The Microscope and Medicine.
[Remarks on the value of the Microscope in medical research.]
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Fleming, J.—Microscopical Studies.
[Lecture to Mutual Improvement Society.]
St. Matthias' (Sulford) Parish Magazine, VIII. (1882) pp. 10–11.

Frasse & Co.'s Mikrometer-Dickmesser. (Micrometrical-measurer of thickness).
[Measures to 1-1000th in.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 274 (1 fig.).

Giltay, E.—Ueber die Abbe'sche Camera Lucida und eine im allgemeinen an Cameras anzubringende Verbesserung. (On the Abbe Camera Lucida and an improvement applicable to Cameras in general.) [*Post.*]
Bot. Centralbl., XII. (1882) pp. 419–22.

Griffith, E. H.—The improved Griffith Club Microscope. [*Supra*, p. 113.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, pp. 149–52 (3 figs.).
Cincinn. Med. News, XI. (1882) pp. 762–4 (2 figs.).

Grunow's (J.) New Camera Lucida. [*Supra*, p. 120.]
Amer. Mon. Micr. Journ., III. (1882) p. 201 (1 fig.).

Gundlach, E.—On Light and Illumination.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 79–90, 255–61.

Hasert, B.—Kombination von Okularlinsen welche die Achromatisirung eines einfachen Kronglas-Objektives direkt bewirken. (Combination of ocular-lenses which effect the achromatising of a single crown-glass objective.)
[Title (only) of German Patent No. 20729, 4th April, 1882.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 288.

Hilgendorf, F. — Apparat für mikroskopische geometrische Zeichnungen. (Apparatus for microscopical geometrical drawings.) [*Post.*]
Zeitschr. f. Instrumentenk., II. (1882) pp. 459–60 (1 fig.).

Hitchcock, R.—Remarks on the Illumination of Insect Preparations mounted without pressure. [*Post.*]
Amer. Mon. Micr. Journ., III. (1882) p. 219.

„ „ The Podura-scale.
[Remarks on the different appearances with objectives of different makers.]
Amer. Mon. Micr. Journ., III. (1882) pp. 224–5.

„ „ Commendation of Spencer's 1-15th in. "Professional" objectives. Also of Tolles' 1-6th in. on *Amphipleura pellucida*.
Amer. Mon. Micr. Journ., III. (1882) p. 238.

„ „ Note on the aperture discussion at Manchester.
Amer. Mon. Micr. Journ., III. (1882) p. 238.

Hitchcock's (R.) Journal.
[Anonymous criticism of note on p. 177 of Vol. III.]
The Microscope, II. (1882) p. 166.

Houghton, W.—The Microscope and some of the wonders it reveals. 4th ed. iv. and 128 pp. (47 figs.). 8vo, London, n. d.

"Jumbo" and "Midget" Microscopes.
["'Among the curiosities recently exhibited by a London Society was the Microscope of half a century ago, weighing 125 pounds, and the 'Midget,' a modern invention, weighing only a few ounces,' so says a newspaper."]
The Microscope, II. (1882) p. 172.

Kent, W. K.—Live Cage for dry objects.
["It consists of a wooden slide, with a cover-glass set near one end, and a spring-clamp near the middle. In other half slides of different thickness cover-glasses were inserted (*sic*), and these, when placed under the spring-clamp, which held them firmly in place, made convenient cells."]
The Microscope, II. (1882) p. 172.

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[Brief reference to a Microscope made by the Nürnberg Industrial School.]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) pp. 255–9.

McCalla, A.—Circular (from the President) to the Members of the American Society of Microscopists.
[Exhortation to co-operation with the officers of the Society to advance the cause of microscopical research and scientific progress.]
14th October, 1882.

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[Records results of measurements—500 or 600.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 201-8 (2 pls.).

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[Vol. II. (1882) p. 271.]
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[Vol. II. (1882) p. 865.]
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NOBERT, F. A.—Die höchste Leistung des heutigen Mikroskops und seine Prüfung durch künstliche und natürliche Objecte. (The best performance of the present Microscopes and their testing by artificial and natural objects.) [*Post.*]
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[A Nose-piece—"its operation resembles that of the self-centering chucks used by mechanics; the objective is held firmly as in a vice, and its centering is perfect. Changing objectives is accomplished with great rapidity and ease."]
Amer. Mon. Micr. Journ., III. (1882) pp. 237.

PELLETAN, J.—Criticism of Dr. Carpenter's remarks on objectives of small and large aperture at the Montreal meeting of the Amer. Assoc. Adv. Sci. [*Supra*, p. 120.] *Journ. de Microgr.*, VI. (1882) pp. 543–4.

PHIN, J.—How to use the Microscope. 5th ed. 264 pp. 12mo, New York, 1882.

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Supplt. to Vol. I. of *Journ. Post. Micr. Soc.* (1882) 17 pp.

"Prismatique."—Object-glass working, III.
Engl. Mech., XXXVI. (1883) p. 397.

Pritchard, Andrew, Death of. *Sci.-Gossip*, 1883, p. 16.

Projection-Microscopes.
[Note *à propos* of Dr. H. Schröder's article II. (1882) p. 673. "The perfecting of such Microscopes would be a desideratum."]
Journ. of Sci., IV. (1882) p. 753.

ROBINSON, W., junr.—Micro-photography.
[Reply to "Density," II. (1882) p. 863.—"The distance between the visual and actinic foci is the same no matter how much the conjugate focus may vary."] *Engl. Mech.*, XXXVI. (1882) p. 324.

ROGERS, W. A.—A study of the problem of fine rulings with reference to the limit of naked-eye visibility and microscopic resolution.
[Title (only) of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci.]
Amer. Natural., XVI. (1882) p. 1050. (Cf. Brief note, also pp. 1042–3.)

„ „ On the conditions of success in the construction and the comparison of standards of length.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 231–51 (1 fig.).

S., W. J.—[Note on the desirability of a universal gauge for eye-pieces and substage fittings.] *Sci.-Gossip*, 1882, p. 276.

SCHROEDER, H.—[Note recording the discovery of optical glass, by the use of which the secondary spectrum is removed, leaving only "an extremely small tertiary spectrum which under ordinary conditions is scarcely visible."]
Centr.-Ztg. f. Opt. u. Mech., III. (1882) p. 261.

SCOTT, E. T.—Microscope Noses and Screws.
["Don't believe that one screw that is turned to fit one body, and is properly adjusted, will really be so for another body."]
Engl. Mech., XXXVI. (1882) p. 362.

Scovill Manufacturing Co.'s apparatus for photographing microscopical objects, Note on. *Amer. Mon. Micr. Journ.*, III. (1882) pp. 218–9.

Smith, H. L.—Memoir of C. H. Spencer.
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 49–74 (Portrait).
Spencer, C. A., Memoir of. See Smith, H. L.
Stearn's (C. H.) Incandescent Electric Light applied to microscopical illumination. [*Supra*, p. 29.] *Engl. Mech.*, XXXVI. (1883) p. 403.
Stowell, C. H. and L. R.—Criticism of the prices asked for some second-hand apparatus. *The Microscope*, II. (1882) p. 176.
Stowell's (C. H. and L. R.) election as honorary members of the Aurora Microscopical Club. *The Microscope*, II. (1882) p. 166.
Suffolk, W. T.—Standard sizes for eye-pieces.
[Calling attention to the recommendations of the Committee, II. (1882) p. 595.] *Sci.-Gossip*, 1883, p. 17.
Sundell, A. F.—Aenderungen in der Brennweite eines achromatischen Objectivs durch Temperatur-variationen. (Changes in the focal length of an achromatic objective through variations of temperature.)
[Experiments on Telescopic Objectives. Description of Apparatus. Differences of 28·1° C. and 31·9° C. produced changes of 1·72 mm. and 2·05 mm.]
Zeitschr. f. Instrumentenk., III. (1882) pp. 410–1, from *Astronom. Nachr.*, No. 2450.
Taylor, G. C.—An Improved Lamp for use with the Microscope.
[Vol. II. (1882) p. 866.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 14 and 273.
Thoulet, —.—Heating Apparatus for the Microscope. [*Post.*]
Amer. Natural., XVII. (1883) p. 76, from *Bull. Soc. Mineral. France.*
Tuttle, Prof. A. H.'s, Address delivered before the new Section of Histology and Microscopy of the Amer. Assoc. Adv. Sci. at Montreal.
[In justification of the formation of the Section.]
Amer. Mon. Micr. Journ., III. (1882) pp. 205–10, 218.
Walmsley, W. H.—Micro-photography with dry-plates and lamp-light and its application to making lantern positives. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 179–82, 273–5.
Ward, R. H.—Report of Committee on Eye-pieces. [Vol. II. (1882) p. 853.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, p. 16.
„ „ Report of National Committee on Micrometry.
[A ruling upon a platino-iridium bar has been tested by the Coast Survey, and will soon be in the hands of the Committee.]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, p. 16.
Watson's Lithological Microscope.
[Described, Vol. II. (1879) p. 470.]
Amer. Mon. Micr. Journ., III. (1882) pp. 226–7 (1 fig.).

β. Collecting, Mounting and Examining Objects, &c.

Carbonic Acid as a Narcotic for Marine Animals.*—Dr. H. Fol recommends carbonic acid as the best narcotic for marine animals so as to preserve their form and habit. The ordinary narcotics, if in small doses, do not render the animals immovable, whilst in large they act as poisons. The same applies to the solutions of ether, chloroform, &c.

If the sea-water in which a Medusa is swimming is saturated with carbonic acid the animal soon becomes completely immovable and insensible, retaining at the same time its natural appearance. If it is left in an hermetically closed vessel it will remain hours and even days unchanged, but immediately becomes lively again when it is placed in pure sea-water. Starfishes remained immovable four days, and

* Zool. Anzeig., v. (1882) pp. 698–9. Bull. Soc. Belg. Micr., ix. (1882) pp. 35–36.

after half an hour in fresh sea-water were as active and healthy as if nothing had happened. The experiment fails, however, for fishes and Mollusca, and Crustacea only endure it for a short time.

In addition to the value of this method for photography, it will prove useful for distributing living marine animals and for physiological purposes.

Corallin as a Microscopical Reagent.*—I. Szyszylowicz distinguishes the various descriptions of mucilage occurring in the vegetable kingdom as follows:—1. Mucilage, i. e. substances which swell in water, are nearly allied chemically to cellulose, are coloured blue by iodine and sulphuric acid or zinc chloride, and which yield oxalic acid when boiled with nitric acid; examples, salep, *Symphytum*, &c. 2. Gums, which also swell in water, dissolving at the same time, are not coloured blue by iodine even on addition of sulphuric acid and zinc chloride, and which yield mucic acid when boiled with nitric acid; examples, *Tilia*, *Osmunda*, &c. 3. Mixtures of mucilage and gum, which the author calls gum-mucilage; and which combine the properties of the two first kinds; these are the most common in the vegetable kingdom; examples, *Linum*, *Plantago*, *Althæa*, &c. At present we have no microscopical reagent for gum, mucilage, or gum-mucilage, except the property of swelling, and the stronger refringence than the surrounding substances; but these are not always sufficient.

Corallin (sometimes called rosolic acid) is obtained by the action of sulphuric acid on phenol in the presence of oxalic acid, and is strictly a pigment composed of aurin and rosolic acid. The author employs it only dissolved in sodium carbonate, when it is of a purple-red colour not changed by exposure to light. The reagent acts differently on the mucilage derived from starch, as in the tubers of Orchideæ, and on that derived from cellulose, as in the root of *Symphytum*.

The colour imparted to starch-mucilage by corallin is remarkably durable; even long-continued boiling in alcohol does not cause any change, which is the more characteristic from the cell-walls and the protoplasm remaining perfectly clear. Cellulose-mucilage is also coloured by corallin, but the colour is destroyed by cold, and still more by hot alcohol. The pigment has no effect whatever on gum. Gum-mucilage is more or less coloured, the shade and permanence of the colour depending on the proportion of the two ingredients. The reagent enables one to detect the smallest quantity of mucilage, and its power of swelling, which has not been the case before. It is of especial value in the examination of the callus in sieve-tubes. In similar cases Russow uses anilin-blue to distinguish the callus-plate; but the author maintains that corallin produces a better result when the callus is beginning to swell or is already dissolved.

The preservation of preparations coloured by corallin is not always possible. The author has preserved very beautiful preparations from starch-mucilage in Canada balsam, but others, and especially those with gum-mucilage, have not been so successful, the

* Osobne odbicie z Rozpran Akad. Umiej w Krakowie, x. (1882). See Bot. Centralbl., xii. (1882) p. 138.

colour being attacked, as might be expected, by the preserving material.

Preparing Bacillus tuberculosis.*—Prof. J. Brun proposes the following "ameliorations" to Koch and Ehrlich's processes.

1st. Not to coagulate the albumen by heat, avoiding desiccation at more than 80° C. At 100° or 120° C. the bacteria are contracted.

2nd. To render the organic matter transparent by acetic acid:—Concentrated nitric acid 5 parts,† glacial acetic acid 10 parts, water 55 parts.

3rd. To neutralize the nitric acid which, remaining to a greater or less extent in the organic layer, at length decolorizes the bacteria and renders them invisible. For this purpose is to be used a concentrated aqueous solution of aniline which neutralizes all the acid not removed by repeated washings.

4th. To avoid Canada balsam, the index of which (1·53) is too high, and to take a neutral liquid having the same index as the albuminoid substances (1·37):—Very white gelatine 14 parts, salicylic acid ·25, distilled water 88.‡ This has an index of 1·356 for the yellow rays. Castor-oil can also be used, though its index is 1·46.

It is better to leave the field uncoloured than to colour it an orange-brown with vesuvine or other colouring matter, because the blue of the bacteria is rendered fainter by the complementary orange tint.

Staining Bacteria.§—Professor C. Weigert adopts two distinct principles in the staining of bacteria for microscopical examination, according as they occur on the one hand in clear liquids or dried masses, or, on the other, in tissues of which, after hardening, sections can be made. For most *Micrococci* all nucleus-staining substances are suitable, viz. (red) all the modifications of carmine, also purpurin, fuchsin, and Magdala-red; (brown) Bismarck-brown, vesuvin; (violet-brown) carmine, the preparations being washed, after staining, in alcohol, to which some chloride of iron has been added; (green) methyl-green; (blue and violet) hæmatoxylin, iodine-violet, methyl-violet, dahlia, gentian-violet.

For staining *Bacilli* and the rare *Megacocci*, anilin colours are alone recommended; carmine and hæmatoxylin produce no effect; of the anilin colours only those which stain nuclei, viz. the basic compounds (e.g. Bismarck-brown, methyl-violet, methyl-green, safranin, fuchsin, magdala, &c.) are applicable; gentian-violet appears to be especially suitable; the objection to methyl-violet and fuchsin is that in decolorizing in order to leave only the nucleus stained, the

* Bull. Soc. Belge Micr., viii. (1882) pp. clxix.-lxxvii. Journ. de Microgr., vi. (1882) pp. 500-3.

† In Bull. Soc. Belge Micr. this is given as 15 parts.

‡ In Journ. de Micr. this formula is not given, but in place of it the following, which in Bull. Soc. Belge Micr. is said not to preserve so well the colour of the bacteria:—Glycerine 10, commercial glucose 40, camphorated alcohol 10, water 140. The index is 1·37.

§ Arch. pathol. Anat. (Virchow), lxxxiv. (1881) pp. 275-94.

colour is apt to go altogether. Some of these colours are unsuited to certain bacteria, e. g. Bismarck-brown does not stain the bacillus of *lepra* at all, and that of splenic fever but badly. In order to stain the bacteria, the sections are placed in a 1 per cent. watery solution of the dye; in a few moments they are deeply coloured, and may then be "differentiated" (the term applied by Professor Weigert to the process of removal of the colour from the body of the cell), by means of alcohol, in which they may be allowed to lie more than an hour; if oil of cloves is used, they may be left in it half an hour and upwards; then if there is not time to examine them, they may be put into water for as much as a day without losing their colour. The use of absolute alcohol for the washing is specially recommended; for gentian-violet, which strongly resists the washing-out process, treatment with oil of cloves, and then with alcohol, transferring back to the oil, is the quickest way. Gentian-violet is particularly useful when it is uncertain what form of bacterium is present, but the colour is removed from the nuclei when placed in glycerine.

Double-staining is very useful for colouring the nuclei and the bacteria differently; of all combinations picrocarmine was found to be the best; it is used as made in the following way, in preference to commercial specimens of this reagent, which Professor Weigert finds are seldom entirely satisfactory:—

Over 2 grammes of carmine are poured 4 grammes common ammonia, and the whole left 24 hours in a place protected against evaporation; 200 grammes of a concentrated picric acid solution are then poured in; the mixture is left 24 hours until all soluble matters are dissolved. Very small quantities of acetic acid are then added until a slight precipitate comes down even after stirring; a rather copious precipitate is usually thrown down in the course of the next 24 hours; it should be removed by filtration.

A picrocarmine which does not stain readily may be improved by addition of acetic acid. After staining, the sections should be washed in pure water or water containing only a trace of acid.

In applying double-staining to bacteria contained in the tissues, the sections should first be treated with gentian violet and alcohol, placed for a moment in water to remove the alcohol and then placed in the picrocarmine and kept there for half an hour or an hour; the superfluous picrocarmine is washed away with water, and the specimen well washed with alcohol and mounted in Canada balsam, after passing through oil of cloves. This method may be applied to *Micrococci*, care being taken not to stain them red by a too protracted sojourn in the picrocarmine.

Actinomyces is not stained by the usual nucleus-staining preparations; *orseille* is used as prepared by Wedl, and the sections left in it for about an hour; they are then washed superficially with alcohol and transferred to gentian-violet. The wall and contents of the cell of *Molluscum contagiosum* are differentiated by this method.

Sections of tissues containing bacteria may be made by Roy's microtome. The frozen sections are examined either fresh or in salt solution; if they are to be stained and mounted they are spread out

with glass needles on a spatula, the superfluous salt solution is removed with blotting-paper, and the section is slowly immersed in absolute alcohol and left there until all air-bubbles have been removed. In all studies of bacteria by staining sections it is important to remember that the staining is apt to fail in the case of some of the micro-organisms, and thus give misleading negative results; the addition of some acetic acid or caustic potash before staining will generally remedy this defect, although the sections are somewhat impaired by these reagents. It is hardly necessary to record Professor Weigert's warning that really good objectives are an absolute necessity for this work.

Preparing Fatty Acids.*—Mr. F. J. Allen boils up the fat or oil with a not too strong solution of caustic soda or potash (liq. sodæ or liq. potassæ) until the alkali is quite saturated and refuses to absorb any more fat. When it has cooled filter it and add dilute sulphuric or hydrochloric acid (stirring and warming at the same time) until no more fatty acid separates. Boil for a second or two, then set aside to cool. When cold, the fatty acid will be found in a solid mass on the surface, and the liquid part may be thrown away.

It is well to boil the acid in *fresh* water to purify it, when, on cooling, it will be practically pure.

To get crystals, it is simply necessary to melt a small quantity on a slide, and spread it *very thin;* it crystallizes on cooling, and must be mounted "dry."

Carmine Solution.†—Prof. H. Hoyer, believing in the great superiority in all respects of carmine for animal tissues, strongly recommends the following as avoiding the objections which exist to the simple solution on account of the difficulty of keeping it, and other disadvantages. He is able to speak from a year's trial.

Dissolve 1 gr. of carmine in a mixture of 1–2 c.cm. of strong liquor ammoniæ and 6–8 c.cm. of water, and heat it in a glass vessel in a sand bath until the excess of ammonia has evaporated. So long as free ammonia is present large bubbles are formed in the fluid, and the latter shows the usual dark purple-red colour of carminate of ammonia. When the free ammonia has evaporated small bubbles appear, and the solution takes a brighter red tint. It is now left to cool and settle, and by filtering, the bright red deposit (to be used over again) is separated from the neutral dark fluid, which by the addition of chloral-hydrate can be kept for a long time.‡

If the carmine solution is mixed with 4–6 times its volume of strong alcohol a scarlet-red precipitate is formed. This is separated by filtration, washed and dried, or made into a paste with alcohol in which some glycerine and chloral is dissolved. Both the powder and the paste can be kept several months unchanged; they dissolve easily in distilled water, particularly the paste. The solution passes readily through the filter, whilst the ordinary carmine solution can

* Journ. Post. Micr. Soc., i. (1882) p. 193.
† Biol. Centralbl., ii. (1882) pp. 17–19.
‡ Cf. *infra*, p. 142, as to its use in the preparation of a red injection-mass

only be filtered with difficulty; it also keeps a long time unchanged, especially with the addition of 1–2 per cent. of chloral, and it has a much more intense colouring power.

By dissolving the carmine powder in a concentrated solution of neutral picrate of ammonia a combination is obtained which unites all the advantages of ordinary "picrocarmine" without any of its disadvantages.

Prussian Blue and Safranine for Plant Sections.*—Prof. J. Brun refers to the process of double staining for vegetable histology described by him to the Geneva Physical and Natural History Society, in which the action of Prussian blue alternates with that of safranine. The process is to be recommended for the clearness with which the preparations show all the minutest details, even in the interior of the cells. The chlorophyll retains its colour, while the cellulose, the layers of the cell-walls and their contents, the incrusting matter, and the fatty or resinous substances are, on the contrary, differently coloured and readily differentiated. He insists on the value of these histo-chemical processes in distinguishing very minute transparent bodies, and above all to differentiate organs scattered through opaline liquids or colourless histological elements.

Injection-Masses.†—Prof. H. Hoyer describes several compounds which he has found useful for this purpose, the essential point being the use of gelatine, the great objection to which is remedied by adding to it chloral hydrate, which protects it from deteriorating by fungoid growths. It is thus possible to have a stock of different coloured masses eminently suited for injection purposes, and which only require to be warmed before immediate use.

For a transparent *red* mass take a concentrated gelatine solution, and add to it a corresponding quantity of the carmine solution described *supra* p. 141. Digest in a water bath until the dark violet-red colour begins to pass into a bright red tint. Then add 5–10 per cent. by volumes of glycerine and at least 2 per cent. by weight of chloral in a concentrated solution. After passing through flannel it can be kept in an open vessel under a bell glass.

A *blue* mass can be made by mixing a small quantity of a *very dilute* and warm solution of Berlin blue with an equally small quantity of a moderately dilute gelatine-solution, by which a clear homogeneous blue solution is obtained. This is again mixed with larger quantities of concentrated warm gelatine-solution, with the gradual addition of now only a moderately dilute solution of Berlin blue. A homogeneous transparent saturated mass is thus produced. The addition of chloral and glycerine enables it to be kept for a long time.

For a fluid yellow in the capillaries and brown in the larger vessels the following is given. A concentrated solution of gelatine is mixed with an equal volume of a 4 per cent. solution of nitrate of

* Bull. Soc. Belge Micr., viii. (1882) pp. clxix.-lxx. Journ. de Microgr., vi. (1882) p. 500.

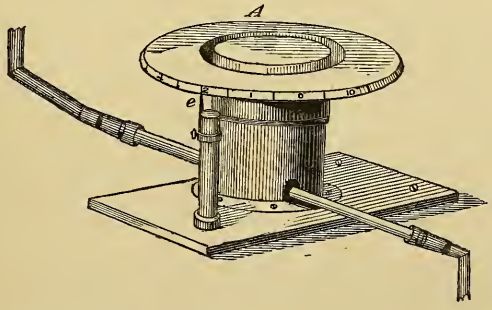
† Biol. Centralbl., ii. (1882) pp. 19–22.

silver, and warmed. To this is added a very small quantity of an aqueous solution of pyrogallic acid, which reduces the silver in a few seconds; chloral and glycerine are added as before. It does not change either in alcohol, chromic or acetic acid, or in bichromate of potash, &c., so that the objects can be hardened in different fluids. Blue and yellow masses mixed give a very useful green.

Prof. Hoyer recalls attention to two other formulæ previously described by him,* but "which have not received any notice in histological text-books." The one is ammonio-nitrate of silver, especially suitable for the endothelium of vessels and fine vessels generally, and much to be preferred to the simple nitrate of silver solution. The other is spirituous solution of shellac.

Taylor's Freezing Microtome.†—This microtome (fig. 29), the invention of Dr. T. Taylor, Microscopist of the Agricultural Depart-

Fig. 29.



ment at Washington, is claimed to present "all the advantages of any plan heretofore employed in hardening animal or vegetable tissues for section cutting, while it has many advantages over all other devices employed for the same purpose.

Microscopists who are interested in the study of histology and pathology have long felt the necessity for a better method of freezing animal and vegetable tissue than has been heretofore at their command. In hardening tissues by chemical agents the tissues are more or less distorted by the solutions used, and the process is very slow. Ether and rhigolene have been employed with some degree of success, but both are expensive and they cannot be used in the presence of artificial light because of danger of explosion. Another disadvantage is that two persons are required to attend to the manipulations, one to force the vapour into the freezing box while the other uses the section-cutting knife. The moment the pumping of the ether or rhigolene ceases, the tissue operated on ceases to be frozen, so ephemeral is the degree of cold obtained by these means.

* Arch. f. Mikr. Anat., xiii. (1877).
† Amer. Mon. Micr. Journ., iii. (1882) pp. 168–9 (1 fig.).

The principal advantages to be obtained by the use of the Taylor Microtome are, 1st, great economy in the method of freezing, and 2nd, celerity and certainty of freezing. With an expenditure of twenty-five cents the tissues to be operated on can be kept frozen for several hours at a time. Small objects immersed in gum solutions are frozen and in condition for cutting in less than one minute."

A is a revolving plate by which the thickness of the section is regulated, and in the centre of which is an insulated chamber for freezing the tissue. A brass tube enters it on each side. The larger one is the supply tube, communicating with a pail on a bracket above the microtome, whilst to the smaller one is attached a rubber tube, which discharges the cold salt water into a pail placed under it. The salt and water liquid, as it passes from the upper to the lower pail, is at a temperature of about zero. The water should not be allowed to waste, but should be returned to the first pail for continual use, or as long as it has freezing properties. As a matter of further economy it is necessary to limit the rate of exit of the freezing water. This is regulated by nipping the discharge tube with the spring clothes-pin supplied for the purpose. Should the cold within the chamber be too intense the edge of the knife is liable to be turned and the cutting will be imperfect. When this occurs the flow of water through the chamber is stopped by using a spring clothes-pin as a clip on the upper tube. In order to regulate the thickness of the tissue to be cut a scale is engraved on the edge of the revolving plate A, which, in conjunction with the pointer *e*, indicates the thickness of the section.

Mr. C. P. Lyman, of the Department of Agriculture, writing in strong commendation of the apparatus, says:—"There is no little box that must be kept full of ice and salt and constantly attended to; neither is there any tiresome bulb to squeeze for a period of anywhere from fifteen minutes to two hours, nor the expense and danger attending the general use of ether or rhigolene. The simplicity of the operation of freezing morbid material for sections, now obtainable through the use of this instrument, will, I think, remove from the study of pathology one of its hitherto greatest bugbears, viz. the great labour of preparation of material for section and the difficulty of obtaining good sections of soft tissues unaltered by the various chemical reagents hitherto used for the purpose of hardening them."

Mounting Media.*—Prof. H. Hoyer has found excellent mounting media not only in L. Bach's solution of gum arabic in liquor ammoniæ aceti, but also in acetate of potash, as well as a third modification with glycerine and chloral. The two former are more particularly suitable for preparations stained with aniline colours, especially bacteria. The latter is suitable for sections hardened in chromic acid, alcohol, &c., and objects coloured with carmine or hæmatoxylin.

* Biol. Centralbl., ii. (1882) pp. 23–4.

The solutions are thus prepared:—A high 60 c.cm. glass with a wide neck is filled two-thirds full with selected white gum arabic (in pieces, not powder), and then acetate of potash or ammonia is added, or a solution of chloral-hydrate (of several per cent.) to which 5–10 per cent. of glycerine has been added. The gum with frequent shaking dissolves in a few days and forms a syrupy fluid, which is slowly filtered for twenty-four hours. The clear filtered fluid will keep a long time, but if spores of fungi begin to develop a little chloral can be added and the fluid refiltered.

Preparation of Dammar Varnish.*—C. J. M. says that none of the receipts given in books enable the amateur to prepare a satisfactory article. Dammar is not entirely soluble in ether, benzole, or turpentine, at ordinary temperatures. If heat be used, the solution is more complete, but, sooner or later, the product will become milky, and then it will be found impossible to clarify it.

To obtain a perfectly limpid solution, permanently remaining so, proceed as follows: To 4 drachms of crushed Indian dammar add 8 liquid drachms of pure benzole, and allow the resin to dissolve at the ordinary temperature. After a day or two, an insoluble residue will be found at the bottom of the vessel. Carefully decant the supernatant clear liquid, and add to it 80 minims ($1\frac{1}{3}$ drachm) of spirits of turpentine. The preparation is then complete. The object of adding turpentine is to ensure toughness in the dried film. Without the turpentine the dried film would be brittle. He does not think that any advantage is derived from the addition of mastic to the preparation.

Hunt's American Cement.†—Mr. J. Ford has received from an American correspondent the following recipe for making the cement, so effectually used by professional mounters, and which has been regarded as a trade secret:—

"Take some zinc white as sold for painters' use, drain off the oil, and mix with Canada balsam, dissolved very thin with chloroform. If it does not flow freely from the brush, add a little turpentine. The mixture should be about the thickness of cream, and kept in a bottle with a glass cap."

Mr. F. J. Allen adds:—Having sealed the slide with the cement, paint on it with artists' oil-colours, thinned if necessary with turpentine, and when dry varnish it with very dilute balsam to give it a gloss.

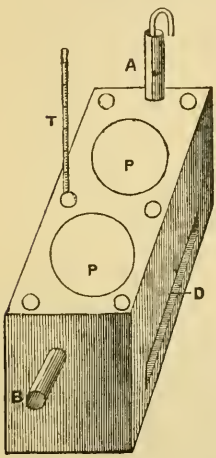
Mayer's Water Bath.‡—A convenient form of water bath, devised by Dr. P. Mayer, is shown in fig. 30.

It is a small brass box, 18 cm. long, 9 cm. wide, and 8 cm. high. The tube A, through which the water is received, and the rod B serve as handles. The receiving tube is closed by a cork provided with a glass tube for the escape of steam, which is bent in the form of

* Sci.-Gossip, 1882, p. 257.
† Journ. Post. Micr. Soc., i. (1882) p. 193.
‡ Cf. C. O. Whitman in Amer. Natural., xvi. (1882) p. 785 (1 fig.).

a siphon to protect against dust. At 1·5 cm. from the base of the box is an oven (D) ·7 cm. high, and 12 cm. long, which passes completely through the box, and serves for warming the slides when shellac is used. Above are two circular basin-like pits (P) 5·5 cm. in diameter, and 4 cm. deep, for receiving the two tin paraffin holders. These are covered by circular plates of glass. There are also six tubular pits, one for a thermometer (T), the other for glass tubes.

Fig. 30.



This water bath will be found useful for other purposes than those of imbedding and mounting. It will of course be understood that the only object of giving its exact dimensions is to furnish a guide where one is required. There are at least two important advantages offered by this water bath over those in general use, viz. the slides are protected from dust, and the paraffin is not exposed to the water.

Packing Slides for Travelling. — Mr. L. Dreyfus describes the mode in which he transported from London to Wiesbaden his collection of over 5000 preparations without a single breakage:—

"I used no wadding whatever, but packed the whole in racked boxes, and over the ends of the slides in the racks only, I put, with the handle of my scalpel, on each side a length of the *smallest* indiarubber tubing, such as is used for feeding-bottles. When the slides were so packed, two more lengths on the top, under the lid, before the latter was fastened down by two of the *stoutest* indiarubber bands across the box in *both* directions (sides and bottom.) This allowed so much spring in every direction that no breakage occurred, although I have no doubt the heavy cases were handled in the usual delicate way by railway porters and sailors on board the steamer.

Besides minimizing the risk of breakage, this style of packing has the advantage of being very easy and expeditious in packing and unpacking, and perfectly clean. The preparations come out as clean as they were packed, and can be packed into the cabinets without the tedious wiping required after the use of cotton wool. Tubes and rings can be used over and over again, so that the extra expense is very small."

Examination of Living Germs in Water.*—At a recent meeting of the Manchester Literary and Philosophical Society, Dr. R. Angus Smith stated that Dr. Koch, of Berlin, advocated the use of gelatine in preserving indications of organic vitality. About $2\frac{1}{2}$ per cent. of gelatine, well heated in a little water, is mixed with the water to be tested, and the mixture forms a transparent mass, in which

* Chem. News, xlvi. (1882) pp. 288–90.

soluble or unobserved matter, developed from the organic matter of the waters and made visible in a solid and insoluble form, does not fall to the bottom, but shows round each active point the sphere of its activity. The gelatine keeps a record, for a time, both of the quality and intensity of life in the liquid, every little centre of life making itself apparent to the eye. It seems, therefore, to Dr. Smith essential that all chemical examinations of water should be supplemented by an inquiry, like this of Dr. Koch's, into the comparative activity of the living organisms. In some waters a centre makes around it a sphere, which has the appearance of a thin vesicle, and is filled with liquid. These spheres form in a day or two, according to the water, and at their bottom is a white mass, containing chiefly active bacteria. The liquid filling the spheres may be taken out by a pipette and examined, with the bacteria which lie at the bottom. Dr. Smith has not yet examined a sufficient number of waters to give general rules, but hopes to do so. He has as yet examined no chalk water for example, but has been confined chiefly to the Manchester district hill water, impure brook and pond water, Mersey, Irwell, and Medlock water, and canal water. In certain specimens of Manchester water the spheres appear on some days to be few in number, on other days the amount is enormous, the whole of the tube in which the experiment is made being filled with them. At such times the water is highly impure, and complained of by the public. Dr. Smith says that when the tests are sufficiently developed, "chemists must prepare for a new condition of things."

Sinel's Embryological Slides. — Sinel & Co. of St. Helier's, Jersey, have issued a series of these slides, in the notice of which they refer to the difficulty of preserving delicate embryological objects for microscopical examination. "The favourite medium of the microscopist has hitherto been Canada balsam, and owing to the non-existence of a cement sufficiently powerful to hold fluid in a cell, this latter medium has been viewed with some suspicion. It would, however, be useless to attempt the preservation of the ova of Crustacea or Mollusca in Canada balsam, but the medium used for these slides, being of the same density as sea-water (and also of such an admirable preservative character that the living appearance of the objects is fully retained) is the most successful yet met with.

"The slides are constructed with a cement of such power and hardness that they have stood a test that would even damage a balsam mount, viz. a temperature ranging from 28° to 120° F., without the slightest effect upon the slide or object, and of the numbers that have been prepared in this manner none have been found to leak, as is frequently the case with ordinary fluid mounts. No slides are sent out till they have been left some considerable time to test and harden."

The list includes the ova, in various stages of development, and the young of Fishes, Mollusca, Insecta, Arachnida, Crustacea, and Echinodermata, with a series of six slides of the anatomy of *Palæmon varians*.

Search for "Atlantis" with the Microscope.* — Under this heading Dr. A. Geikie reviews a paper† by the Abbé Renard "On the Petrology of St. Paul's Rocks," an island nearly on the equator, and about 500 miles east of the South American coast:—

"Are these rocks the last enduring remnant of 'Atlantis'—a continent that has otherwise disappeared, or are they portions of a volcanic mass like the other islands of the same ocean? To those who have not noted the modern progress of geological inquiry, it may seem incredible that any one should propose to solve this problem with the Microscope. To seek for a supposed lost continent with the help of a Microscope may seem to be as sane a proceeding as to attempt to revive an extinct *Ichthyosaurus* with a box of lucifer-matches. Yet in truth the answer to the question whether the St. Paul's Rocks are portions of a once more extensive land depends upon the ascertained origin of the materials of these rocks, and this origin can only be properly inferred from the detailed structure of the materials, as revealed by the Microscope. The importance of microscopical examination in geological research, so urgently pressed upon the notice of geologists for some years past, has sometimes been spoken of disparagingly, as if the conclusions to which it led were uncertain, and hardly worth the labour of arriving at them. We occasionally hear taunts levelled at the 'waistcoat-pocket geologists,' who carry home little chips of rock, slice them, look at them with their Microscopes, and straightway reveal to their admiring friends the true structure and history of a whole mountain-range or region. That the sarcasm is often well-deserved must be frankly conceded. Some observers with the Microscope have been so captivated with their new toy as to persuade themselves that with its aid they may dispense with the old-fashioned methods of observation in the field. But there could not be a more fatal mistake. The fundamental questions of geological structure must be determined on the ground. The Microscope becomes an invaluable help in widening and correcting the insight so obtained; but its verdict is sometimes as ambiguous as that of any oracle. In any case it must remain the servant, not the master, of the field-geologist."

M. Renard has undertaken a most elaborate investigation (chemically and microscopically) of sections of the rocks brought home by the 'Challenger,' with the view of determining whether they were to be considered as volcanic or to be classed among the crystalline schists. If they belong to the latter, they must once have lain deeply buried beneath overlying masses, by the removal of which they have been revealed. They would thus go far to prove the former existence of much higher and more extensive land in that region of the Atlantic; land, too, not formed of mere volcanic protrusions, but built up of solid rock-masses, such as compose the framework of the continents. If, on the other hand, the rock is volcanic, then the islets of St. Paul belong to the same order as the oceanic islands all over the globe. The Abbé inclines on the whole to the side of the crystalline schists,

* Nature, xxvii. (1882) pp. 25-6. † Ann. Soc. Belg. Micr., ix. (1882).

but Prof. Geikie considers that the balance of proof is decidedly in favour of the volcanic origin of the rock.

Cole's Studies in Microscopical Science. — These have now reached the 40th number, and fully support the high praise which has been bestowed upon them in every direction, both for the information contained in the text, the beauty of the coloured illustrations, and the excellence of the accompanying slides. Microscopists have long lamented that it was not possible to obtain a guide to the slides sold, so that the points of interest illustrated could be intelligently appreciated. Now that this is provided, it is to be hoped that they will bear in mind that something more is required than "moral" support in order to ensure a continuation of the series. So many useful ventures have failed through microscopists trusting to their neighbours to provide substantial support, that it is necessary to urge that every one who believes in the value of Mr. Cole's enterprise will himself subscribe to it. No more profitable return can, we are sure, be found for the small outlay required.

Allen, F. J.—Dr. Hunt's American Cement for Ringing Slides. [*Supra*, p. 145.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

„ „ Fatty Acids to prepare for the Microscope. [*Supra*, p. 141.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

Blanc, H.—Encore une méthode pour conserver et colorer les Protozoaires. (Another method for preserving and colouring the Protozoa.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 22–3.

Bonchut, E.—Traité de Diagnostic et de Sémiologie comprenant l'exposé des procédés physiques et chimiques d'exploration médicale, auscultation, percussion, cérébroscopie, sphygmographie, laryngoscopie, microscopie, analyse chimique et l'étude des symptomes fournis par les troubles fonctionnels.
[Chap. XIV. Emploi de la loupe et du Microscope. (Employment of the lens and the Microscope.) pp. 155–76 (18 figs.).]
8vo, Paris, 1883, xi. and 692 pp. (160 figs.).

Chester, A. H.—Method of making Tin Rings for Cells. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 282–3.

Cohen, E., & J. Grimm.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Struktur von Mineralien und Gesteinen. (Collection of Microphotographs for the demonstration of the Microscopical Structure of Minerals and Rocks.) Part VII. 8 pls. 4to, Stuttgart, 1882.

Cole, A. C.—Studies in Microscopical Science.
No. 30 (pp. 209–216).—T. S. Thallus of Lichen. *Sticta aurata.* Plate of 15 figs.
No. 31 (pp. 217–220).—The Pancreas. T. S. of Human Pancreas, injected carmine. Plate × 65.
No. 32 (pp. 221–6).—Diabase. South Quarry, Corstorphine Hill, Edinburgh. Plate × 25.
No. 33 (pp. 227–30).—The Spleen. T. S. of Human Spleen (of Infant), injected carmine and stained with hæmatoxylin. Diagrammatic Drawing.
No. 34 (pp. 231–4).—*Juncus communis* var. *effusus.* T. S. of Stem. Plate × 250.
No. 35 (pp. 235–40).—The Spleen. T. S. Spleen of Cat, stained logwood. Plate × 65.
No. 36 (pp. 241–2).—*Euphorbia splendens.* L. S. of Stem, stained logwood. Plate × 65 and 500.
No. 37 (pp. 243–50).—The Salivary Glands. V. S. Submaxillary Gland of Dog, stained logwood. Plate × 500.
No. 38 (pp. 251–6).—Section of Rock—Red Syenite. Ord Hill, Sutherland. Plate × 25. Description by Prof. M. F. Heddle.

Cornil & Ranvier.—Manual of Pathological Histology. Transl. by Hart. 2nd ed. Vol. I. 8vo, London, 1882.

Cutting Sections of Dental Pulp.

["Harden in 1 per cent. aqueous solution of chromic acid, separated from the dentine; or take fresh pulp from the extracted tooth, stain with carmine, harden in glycerine to which add 1 per cent. acetic acid. In three to six months sections could be cut with a keen razor."]

The Microscope, II. (1882) p. 172, from *New England Journal of Dentistry*.

Deecke, T.—Preparation and Mounting of Brain Sections. [*Post.*]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 275–80.

Fol, H.—Ein Beitrag zur Technik für Zoologen am Meeresstrande. (A Contribution to Technics for Zoologists at the Sea-shore.) [*Supra*, p. 137.]

Zool. Anzeig., V. (1882) pp. 698–9.

and in French in *Bull. Soc. Belg. Micr.*, IX. (1882) pp. 35–7.

Ford, J.—Dr. Hunt's American Cement for Ringing Slides. [*Supra*, p. 145.]

Journ. Post. Micr. Soc., I. (1882) p. 193.

Freeman, H. E.—Grinding Sections of Teeth.

[Employ ground-glass, using with it in the early stage fine-ground pumice-stone.]

Journ. Post. Micr. Soc., I. (1882) p. 192.

Frenzel, J.—Beitrag zur Microscopischen Technik—Aufkleben der Schnitte. (Contribution to Microscopical Technics—Fixing the Sections.) [*Post.*]

Zool. Anzeig., VI. (1883) pp. 51–2.

Friedlaender, C.—Microscopische Technik zum gebrauch bei medicinischen und pathologisch-anatomischen Untersuchungen. (Microscopical Technics for use in medical and pathologico-anatomical investigations.) viii. and 132 pp., 8vo, Kassel and Berlin, n.d.

Gage, S. H.—Observations on the Fat Cells and Connective-tissue Corpuscles of *Necturus* (*Menobranchus*).

[Contains "Methods of Investigation" and making "Permanent Microscopic Preparations."]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 109–26 (1 pl.).

Griesbach, H.—Bemerkungen zur Injectionstechnik bei Wirbellosen. (Remarks on the Injection of Invertebrata.) [*Post.*]

Arch. f. Mikr. Anat., XXI. (1882) pp. 824–7.

Grimm, J. See Cohen, E.

Hager, H.—Arsennachweis auf mikroskopischem Wege. (Microscopical Analysis of Arsenic.) *Chem. Centralbl.*, XIII. (1882) pp. 690–1, from *Pharm. Centralh.*, XXIII. (1882) pp. 367–9.

Hauck, F.—Die Meeresalgen Deutschlands und Oesterreichs. (The Marine Algæ of Germany and Austria.) 8vo, Leipzig, 1883.

[2nd vol. of Dr. L. Rabenhorst's Cryptogamic Flora of Germany, Austria, and Switzerland. 1st part contains Introduction (pp. 1–6) on "The Collection and Preparation of Marine Algæ."]

Hitchcock, R.—Examination and Exhibition of Living Organisms.

[Place a drop of water containing the organisms on a cover-glass and invert over a ring of wax on a slide—melt the wax with a piece of wire to make the cell air-tight. A small bit of *Nitella*, *Anacharis*, or some vigorously growing alga should be placed in the drop. In this way rotifers can be seen to develope and multiply for days. The plan is also recommended for showing cyclosis in a water plant.]

Amer. Mon. Micr. Journ., III. (1882) p. 222.

„ „ The Mounting of Pollen Grains.

[Dry—in wax cells (dusted in). Fluid—in castor-oil in shellac cells.]

Amer. Mon. Micr. Journ., III. (1882) p. 223.

Hurst, G. H.—The Microscopical Structure of Rocks.

[Contains notes on the Microscope required and on preparing rock-sections.]

Field Naturalist, I. (1883) pp. 169–71.

Ingpen, J. E.—Bleaching Leaves.

[Note as to making chlorinated soda and mounting the leaves in glycerine jelly.]

Journ. Post. Micr. Soc., I. (1882) p. 191.

KLAASEN, H. M.—To mount Plants in Glycerine and Water.
[Add to the glycerine a few drops of carbolic acid to guard against fungoid growth—mix with equal parts water—don't cement the cover-glass down, but let the water evaporate, and add more glycerine and water until the plant gets gradually filled with glycerine. Fasten the cover-glass by first ringing it with gelatine, to which any cement will adhere.]
Journ. Post. Micr. Soc., I. (1882) p. 192.

KOSMAN, R.—Zur Microtomtechnik. (On Microtomes.) [*Post.*]
Zool. Anzeig., VI. (1883) pp. 19–21.

LACHMANN, J. P.—See Poulsen, V. A.

LOFTHOUSE, T. W.—Mounting the Proboscis of a Fly—Preparation. [*Post.*]
Micr. News, III. (1882) pp. 21–2 (1 fig.).

MARCHAL, E.—Des moyens matériels dans l'enseignement de la botanique. Le Microscope. 22 pp. (Materials for the teaching of Botany—The Microscope.) 8vo, Bruxelles, 1882.
„ „ Essai d'une liste de préparations microscopiques destinées à l'enseignement. 16 pp. (Attempt at a list of microscopical preparations intended for teaching.) 8vo, Bruxelles, 1882.

Marlow's (E.) Microscopical Compendium.
[Cabinet for turntable, slides, brushes, bottles, &c.]
Sci.-Gossip, 1882, p. 277.

Mikroskopische Präparate von Mikroorganismen, speciell v. pathogenen Bacterien. Collection I. (Unter Controle v. Flügge in Göttingen angefertigt.) (Microscopical preparations of micro-organisms, especially of pathogenous Bacteria. Prepared under the direction of Flügge of Göttingen.) Cassel, 1882.

MÖBIUS, K.—Kleine Mittheilungen aus der Zoologischen Technik. (Minor communications on Zoological Technics.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 52–3.

MOORE, A. J.—The preparation of Crystals.
[The plan proposed has been found very unsatisfactory in England.]
The Microscope, II. (1882) p. 164.

MULLER, C. J.—On the discrimination of different species of wood by a microscopical examination of sections of branches. *Sci.-Gossip*, 1883, p. 9.

PARSONS, H. F.—Preventing growth of Mildew on dry Mounts.
[Paint the specimen and the interior of the cell with a solution of carbolic acid or corrosive sublimate in spirit before mounting.]
Journ. Post. Micr. Soc., I. (1882) p. 193.

PAUL'S (F. A.) Modification of Williams' Freezing Microtome. [*Post.*]
Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 283–4.

POULSEN, V. A.—Microchimie végétale, guide pour les recherches phyto-histologiques à l'usage des étudiants. (Vegetable Microchemistry, guide to phyto-histological researches for the use of students.) Translated by J. P. Lachmann from the German edition. French edition, considerably enlarged (in collaboration with the author). xx. and 119 pp. 8vo, Paris, 1882.

REDDING, T. B.—Osmic acid—its uses and advantages in microscopical investigations. [*Post.*] *Proc. Amer. Soc. Micr.*, 5th Ann. Meeting, 1882, pp. 183–6.

REINSCH, P. F.—Mikrophotographien über die Struktur und Zusammensetzung der Steinkohle des Carbon entnommen von mikroskopischen Durchschnitten d. Steinkohle. (Microphotographs of the Structure and Composition of Coal from Microscopical Sections.) 73 photographs on 13 plates and a photographic frontispiece. Leipzig, 1882.

ROGERS, W. A.—On a new form of dry mounting.
[Title (only) of paper read in the Microscopical Section of the Amer. Assoc. Adv. Sci.]
Amer. Natural., XVI. (1882) p. 1050.

S., W. J.—Note on Mounting for Hot Countries.
[Cf. II. (1882) p. 288—Report of satisfactory results with balsam and benzol and dammar and benzol.]
Sci.-Gossip, 1882, pp. 276–7.

SARGENT, W., junr.—Bleaching Fluid for Insects.
[Hydrochloric acid, 10 drops; chlorate of potash, ½ dr.; water, 1 oz. Soak for a day or two. Wash well.]
Journ. Post. Micr. Soc., I. (1882) p. 192.

Schiefferdecker, P.—Ueber eine neue Injectionsmasse zur Conservirung der Leichen für dem Präparirsaal. (On a new injection-mass for preserving bodies for the preparing room.) *Arch. f. Anat. u. Entwick.*, 1882, pp. 197–8.

„ „ Ueber die Verwendung des Celloidins in der Anatomischen Technik. (On the use of Celloidin in anatomical technics.) *Arch. f. Anat. u. Entwick.*, 1882, pp. 199–203.

Schulgin, M.—Zur Technik der Histologie. (On histological technics.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 21–2.

Slack, H. J.—Pleasant Hours with the Microscope.

[Disease Germs—Potato, Starches, &c., with Polarized Light.]

Knowledge, III. (1882), pp. 7–8, 34–5.

Stirling, W.—The Sulphocyanides of Ammonium and Potassium as histological reagents. [*Post.*] *Journ. Anat. & Physiol.*, XVII. (1883) pp. 207–10.

Stowell, C. H.—How to preserve Urinary Deposits.

[In Canada balsam, in glycerine, in a 1 per cent. solution of carbolic acid, in equal parts of glycerine and camphor-water, in a solution of naphtha and creosote, &c. Special directions as to the latter.]

The Microscope, II. (1882) pp. 161–2.

„ C. H. and L. K.—Microscopical Diagnosis, viii. 96, 114, 32 pp., 37, 78, and 16 figs., 10 pls. 8vo, Detroit, 1882.

Taylor, T.—A new freezing Microtome. [*Supra*, p. 143.]

Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 153–5 (1 fig.).

Teasdale, W.—Bleaching Leaves.

[Leaves of *Arabis albida* bleach rapidly in chloride of lime, and give charming results.]

Journ. Post. Micr. Soc., I. (1882) p. 191.

Vereker, J. G. P.—To mount in glycerine.

[Heat indiarubber till it becomes sticky, dissolve it in benzol, ring both cover and slide, then let it remain till tacky; arrange the object in glycerine, press down the cover, wash away spare glycerine, and run asphalte varnish or other finish. "The advantages are, the indiarubber sticks in spite of the glycerine, and is elastic, and so a great amount of trouble is saved."]

Journ. Post. Micr. Soc., I. (1882) p. 192.

Wade-Wilton, E.—Pond-hunting in winter.

[Remarks on the importance of collecting in winter as well as summer, and notes of organisms to be obtained.]

Journ. Post. Micr. Soc., I. (1882) pp. 183–5.

Walmsley, W. H.—Some hints on the preparation and mounting of microscopic objects. 32 pp. and 16 figs.

[Forms Part III. of Stowell's 'Microscopical Diagnosis,' *supra*.]

8vo, Detroit, 1882.

Warren, R. S.—Cleaning Diatoms.

[Reply to Mr. Kitton, II. (1882) p. 707, and agreeing that Mr. Kitton's description of his process is very like that of the author, but that is an accidental coincidence.]

Amer. Mon. Micr. Journ., III. (1882) pp. 225–6.

Wasse, G. M.—Continuous observation of Micro-fungi.

[Inquiring for information about observing the germination of fungus-spores under the Microscope.]

Sci.-Gossip, 1882, p. 277.

Whitman, C. O.—Orientation in Microtomic Sections—The reconstruction of objects from sections—Method of reconstruction.

[All in Vol. II. (1879) p. 71.]

Amer. Natural., XVII. (1883) pp. 109–12.

PROCEEDINGS OF THE SOCIETY.

Meeting of 13th December, 1882, at King's College, Strand, W.C., James Glaisher, Esq., F.R.S., in the Chair.

The Minutes of the meeting of 8th November last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Schulze, F. E.—Ueber den Bau und die Entwickelung von *Cordylophora lacustris* (Allman). 52 pp., 6 pls. (4to. Leipzig, 1871.)	
Rabenhorst, L.—Beiträge zur näheren Kenntniss und Verbreitung der Algen. Hefts 1 and 2. 30 and 40 pp., 7 and 5 pls. (4to. Leipzig, 1863-5.)	
Wallich, G. C.—The North-Atlantic Sea-bed. Part 1. 106 pp., map, and 6 pls. (4to. London, 1862.)	
Krause, C. F. T. and W.—Handbuch der Menschlichen Anatomie, Nachträge zur Allgemeinen und Microscopischen Anatomie. viii and 170 pp., 81 figs., and 1 pl. (8vo. Hannover, 1881.)	
Rossmässler, E. A. — Das Süswasser-Aquarium. 3rd ed. 96 pp., 53 figs., and 1 pl. (8vo. Leipzig, 1875.)	
Zaddach, E. G.—De Apodis Cancriformis. viii and 76 pp. and 4 pls. (4to. Bonnæ, 1841).	
Various reprints, including Milne Edwards' 'Ascidies composées,' 1839 (110 pp. and 8 pls.); Reichert's '*Zoobotryon pellucidus*,' 1870 (106 pp. and 6 pls.); Dodel's '*Ulothrix zonata*,' 1876 (136 pp. and 8 pls.); Dumortier and Van Beneden's 'Polypes composés d'eau douce,' 1850 (96 pp. and 6 pls.); Zopf's 'Conidienfrüchte von *Fumago*,' 1878 (75 pp. and 8 pls.); Cohn's 'Untersuchungen über die Entwickelungsgeschichte der Mikroskopischen Algen und Pilze,' i. (156 pp. and 6 pls.); Muller's 'Classification des Lichens,' 1862 (95 pp. and 3 pls.); De Bary and Woronin's 'Morphologie und Physiologie der Pilze,' 1864–70, Parts 1–3, 96, 43, 36 and 95 pp., 6, 8, 6 and 6 pls.; Möbius's '*Eozoon Canadense*' (20 pp. and 18 pls.); Gravenhorst's 'Infusorienwelt,' 1832 (66 pp. and 1 pl.); Brefeld's '*Empusa muscæ* and *E. radicans*,' 1871 (50 pp. and 4 pls.); and 12 others	*Mr. Crisp.*

The Chairman gave notice that the next meeting would be made special for the purpose of admitting of the nomination of Prof. P. Martin Duncan as President for a third year in succession, a proposal which he felt sure would be received with entire satisfaction.

Mr. G. F. Dowdeswell read a paper on "A Minute Form of Parasitical Protophyte" (see p. 26), descriptive of a section, exhibited

under a Microscope, of the lung of a mouse infected with a form of septicæmia.

The Chairman thought the experiments described were very important, from the fact of their having been conducted under such high powers. Investigations of this kind required an amount of time and a delicacy of manipulation which might well make the Society grateful to any one who bestowed upon them the necessary attention. He was very glad that Mr. Dowdeswell intended to continue the same line of investigation, and that he had promised they should hear the results of his further researches.

Mr. Crisp exhibited (1) Martens' Ball-jointed Microscope (Vol. II. (1882) p. 672); (2) Hartnack's (or Recklinghausen's) Demonstration Microscope (Ibid., p. 97); and (3) the latest form of Mr. E. H. Griffith's Club Microscope (*ante*, p. 113).

Mr. F. Kitton's paper on "Binocular Vision in the Study of the Diatomaceæ" was read.

Mr. Beck said, that with reference to the opening remarks of the author on the value of binocular over monocular vision, he could fully bear out all that had been said. A valuable means of convincing any one who was sceptical on the subject was to be found in a slide of *Aulacodiscus;* and he remembered that when his brother Richard showed this diatom to Mr. Tuffen West for the first time under the binocular, that distinguished draughtsman looked at it for some time in silence, and then jumping up, exclaimed, "All the drawings of Diatomaceæ which I have done will have to be done over again."

Dr. Wallich said he could fully confirm the statement that nothing showed diatoms so well as the binocular. Indeed, from a study of these objects extending over many years, he could say that it was utterly impossible to see them in any other way. In one of the drawings of *Hydrosira*, he observed that Mr. Kitton had not noted the unsymmetrical formation consisting of a little dot which was generally surrounded by a slight ridge on one side only. It occurred in *Hydrosira* and many of the discoidal forms, and, though often seen, he had never been able yet to detect what this peculiar structure was. It would be of advantage if some one would set to work to determine it. It seemed to him to have something to do with the communication between adjacent frustules.

Mr. Crisp said that Mr. Kitton had proved conclusively the superiority of the binocular, in that he had shown the true form of diatoms, which had previously been misinterpreted by most experienced observers after observation with the monocular.

Dr. Wallich, in reply to Mr. Badcock, stated that in examining these objects under high powers, he used the thinnest slide he could find and the thinnest cover-glass. Generally he used one of Hartnack's objectives; the only difficulty was to get the whole of the field illuminated, but it was not really necessary in by far the larger number of cases to use more than the central part of the field, which could always be illuminated.

Mr. James Smith said that, in working with high powers under the binocular, he had always found it of great advantage to use a finely-ground glass slip under the slide on which the object was mounted. If a 1-4th in. or a 1-8th in. were used under ordinary circumstances, the black division across the field was seen, but the ground glass seemed to obliterate this entirely. He generally used a piece of very pale blue glass, ground on the upper surface.

Mr. Stewart referred to the importance of approximating the back lens of the objective to the binocular prism. With the ordinary Wenham prism they were limited to powers of 400 to 500, but with the Stephenson arrangement it was quite easy to work with a 1-25th in. There seemed still to be persons who appeared to think that the binocular was a mere toy. It was, however, of really great importance, especially when working on an exceedingly transparent object, where the inner membranes could be seen distinctly separated from those above them; or in tracing out fine nerve-fibres, which, passing over or under each other, could be resolved in a way which was entirely impossible by any other means.

Mr. Crisp pointed out the means that had been adopted for using the Wenham prism with the higher powers by fitting it into a tube which could be passed inside the objective.

Mr. Beck believed they were only as yet in the infancy of the binocular Microscope, and he looked forward to the time when much more attention would be paid to its construction, and particularly to the question of ascertaining the best point at which the prism should be placed to get the full field without adventitious aid in the way of illuminators, by which improved results would no doubt be obtained. He believed that the binocular was the Microscope which would be used in the future.

Dr. Wallich said that with reference to ground glass he might mention that some time ago he accidentally found some glass which had been near a guttapercha bottle of hydro-fluoric acid, the fumes of which had acted upon the glass and frosted it in a far finer manner than could be done with the finest emery powder. The condenser he used was the ordinary "Gillet," with which he had no difficulty. Another thing which he found very useful with the bull's-eye condenser was to fix a piece of light-blue glass on the near side of it; the light from this was so good that he could confidently recommend the plan.

Dr. Gibbes said he could corroborate all that had been said on the subject of the binocular, and especially its value when used with a 1-12 in. in examining those very minute parasites to which his attention had been given, as it enabled him at once to see whether they were outside or inside the tissue.

Mr. Dreyfus's Note was read, describing a safe method of packing slides in a cabinet for railway and sea transit (see p. 146).

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—*Pyxicola affinis* and *Euglena oxyuris.*

Mr. Crisp:—(1) Improved Griffith Club Microscope. (2) Hartnack's (or Recklinghausen's) Demonstration Microscope. (3) Martens' Ball-jointed Microscope.

Mr. Dowdeswell:—Section of lung of septicæmic mouse.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. W. M. Bale, Abraham D. Balen, Walter H. Bulloch, C. E. Hanaman, J. Satchill Hopkins, J.P., William C. Ondaatje, L.M.S. Beng., C. H. Stearn, John L. Wall, and David Welsh.

Conversazione.

The first Conversazione of the Session was held on the 6th December last in the Libraries of King's College, when the following objects, &c., were exhibited:—

Mr. Baker:
- Zeiss's Small Dissecting Stand, with Compound Objective, Large Dissecting Microscope, and Travelling Microscope.
- Hartnack's Histological Microscope.
- Arranged Tests (*Pleurosigma*) in balsam.

Mr. Badcock:
- *Epistylis* with Flagellata, and *Lophopus crystallinus.*

Mr. F. P. Balkwill:
- 200 Foraminifera arranged and named on one slide.

Mr. Blackburn:
- Cast skins of nymph and sub-imago of *Heptagenia longicauda*, one of the Ephemeridæ.

Messrs. R. and J. Beck:
- New Petrological Microscope, and *Bacilli* in lung of cow.

Mr. W. G. Cocks:
- *Hydra vulgaris* developing winter eggs.
- Pencil Tails (*Polyxenus lagurus*) and *Volvox globator.*

Mr. A. C. Cole:
- Sporocarp of *Pilularia globulifera* in section.

Mr. Creese:
- Pitcher of *Nepenthes distillatoria* showing acid glands.

Mr. F. Crisp:
- Slides illustrating the views of Drs. Loew and Bokorny on the chemical difference between dead and living protoplasm.

Mr. Curties:
- *Notamia bursaria* polarized.

Mr. Dowdeswell:
- Nerve-fibre, showing the reticulated structure of the sheath.

Mr. Enock:
- *Tingis hystricellus* from Ceylon, and *Hæmatopinus suis.*

Mr. F. Fitch:
- Reproductive organs of a bee.

Mr. Guimaraens:
Quartzite from S. America and sandstone from Cheshire, exhibited for comparison with the so-called "Braunfels Meteorite."

Mr. Groves:
Capillary network of tracheæ on duct of salivary gland of cockroach.
Improved Groves-Williams Ether Freezing Microtome.

Dr. Gibbes:
Bacillus tuberculosis in sputum, and injected human lung from a case of Acute Tuberculosis.

Mr. H. F. Hailes:
Arenaceous Foraminifera.

Mr. Hardy:
Chromatoscope.

Mr. Hood:
Floscularia ambigua Hudson.

Mr. Ingpen:
Professor Abbe's Test-plate.

Mr. Joshua:
Bulbochæte sessilis, and some Desmids.

Dr. Millar:
Mylinsia Fittelli, a Hexactinellous Sponge.

Mr. Michael:
Specimen of *Mymar* and *Uropoda formicariæ*, a new species of predatory mite discovered by Sir John Lubbock, Bart.

Mr. E. M. Nelson:
Amphipleura pellucida (dry on cover), with Powell and Lealand's oil-immersion 1-25th, N.A. 1·38 (130° in glass).
Pleurosigma formosum (dry on cover), with Powell and Lealand's low-angled dry 1-4th, N.A. ·77 (100° in air).

Mr. Priest:
Statoblasts of two new *Spongillæ* described by Mr. Carter, *S. Bombayensis* and *S. segregata*.

Messrs. Powell and Lealand:
Scale of *Podura* with 1-20th oil-immersion, N.A. 1·38.
Amphipleura pellucida with 1-12th oil-immersion, N.A. 1·43.

Mr. Reed:
Section of leaf of *Hedychium Gardnerianum*.

Mr. G. Smith:
Transparent photographs of rock sections by polarized light, and section of Nepheline Dolerite.

Mr. J. Smith:
Wing of peacock butterfly.

Mr. C. H. Stearn:
Microscopes illuminated by minute Swan incandescence lamps.

Mr. Chas. Stewart:
Botryllus sp.?

Messrs. Swift and Son:
Eggs of parasite of Ground Hornbill.

Mr. H. J. Waddington:
Lactate of copper and copper deposited by electrolysis.
Mr. J. G. Walker:
An undescribed British sponge; parasitic and coating. It has a new form of spicule sparsely distributed on membranes.
Mr. F. H. Ward:
Sections of *Cycas revoluta*, and dahlia root showing inulin.
Mr. T. Charters White:
Teeth of blow-fly, and the valve of salivary duct of blow-fly.

Meetings of 10th January, 1883, at King's College, Strand, W.C., The President (Professor P. Martin Duncan, F.R.S.) in the Chair.

The Minutes of the Meeting of 13th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Fromentel, E. de.—Introduction à l'étude des Polypiers fossiles. 357 pp. (8vo. Paris, 1858–61.)	
Klencke, P. F. H.—Ueber die Contagiosität der Eingeweidewürmer nach Versuchen und über das physiologische und pathologische Leben der mikroskopischen Zellen nach empirischen Thatsachen. iv. and 42 pp. (8vo. Jena, 1844.)	
Ziegler, M.—Lutte pour l'éxistence entre l'organisme animal et les Algues microscopiques. iv. and 80 pp. (8vo. Paris, n.d.)	
And 9 reprints on Milk, Foraminifera (6), Colouring Matter in Plant Cells, and Algæ	*Mr. Crisp.*
Mason, J. J., M.D.—Minute Structure of the Central Nervous System of certain Reptiles and Batrachians of America. 113 photo-micrographs, xxiv. pp. (Fol. Newport, U.S.A., 1879–82)	*The Author.*
Slide of *Bugula turbinata*, with tentacles extended and stained	*Mr. H. C. Chadwick.*

Special attention was called by the President to the volume presented by Dr. Mason.

Mr. Crisp exhibited (1) Mikulicz's Stomach Microscope and (2) Crouch's Portable Histological Microscope.

Mr. J. D. Hardy read a note on a method of illumination by means of the Chromatoscope (see p. 126).

Mr. Stewart said that no doubt most of the Fellows who were present at their last Conversazione saw this apparatus exhibited and observed that it did most efficiently add to the beauty of objects shown, which were not amenable to the action of the polariscope. It was not demonstrated, however, that it enabled any one to find out the structure of objects better, though it certainly added to their beauty.

The President said that several of the Fellows had been in the

habit of using different tinted glasses, and there could be no doubt that a blue or red and perhaps even a violet glass placed on the mirror or bull's-eye was of great use in many examinations. The violet tint seemed to be of less use than the others, because this colour was not so favourable to the eye. He had himself frequently used green with opaque illumination and found it enabled him to examine objects for a longer time than was possible by ordinary yellow light. There was, however, this important difference between the use of tinted light and polarized light, that it did not enable any one to see hidden structures which polarized light so often displayed. In corals, for instance, whilst coloured light was much better for their examination than common yellow light, yet polarized light gave an insight into their structural peculiarities—showing how the object had been originally built up—in a way which mere variety of tint was quite incapable of doing. He was glad to see this effort on the part of Mr. Hardy to add to the beauty of some of their favourite objects, especially as he felt that the attention given of late to high powers had caused the æsthetics of the Microscope to become somewhat neglected.

Mr. J. Mayall, junr., exhibited the stage by R. B. Tolles, of Boston, U.S.A., which he thought would be of interest to the Fellows after the description of it which appeared in the Journal, I. (1881) p. 944.

Mr. Beck exhibited an objective (without adjustment collar) of 1-6th in. focus, made specially for the binocular with very short setting, so that the back lens would lie close to the prism.

Mr. Ingpen remarked that the difficulty of obtaining any adjustment for cover-glass was the great stumbling-block in the way of the manufacture of such lenses.

Mr. C. H. Stearn read his paper "On the Use of Incandescence Lamps as Accessories to the Microscope" (see p. 29), the subject being illustrated by the exhibition of the arrangements.

The President said he felt sure the Society was very much obliged to Mr. Stearn for having shown them this very excellent adaptation of electric lighting to the Microscope. It showed them very plainly what they would have to come to, and he hoped it pointed to a speedy annihilation of all rock-oil abominations. The great convenience of having a light so completely under command struck him as a great point about it; for in examining such objects as Echinoderms with a 2-in. objective, what was specially wanted was a light that could be twisted and twirled round the object in the way shown by Mr. Stearn. He sincerely hoped that the idea would be fully worked out, and that it would be taken up by some of their great makers. No doubt those who saw these little lamps exhibited at their last Conversazione would agree with him in thinking that it was one of the most interesting exhibitions ever brought before them.

Mr. Stearn, in reply to questions from Mr. Beck and Mr. Crisp, said that the accumulators which were under the table in the room would work the lamps for several hours consecutively, but he was

unable to say how long they would last without recharging if they were put on one side, and not used for some days. He thought a good deal of the current might be dissipated meanwhile.

Mr. A. D. Michael read a paper "On the Anatomy of the Oribatidæ" (see p. 1), the subject being illustrated by diagrams, and specimens shown under the Microscope.

Mr. Stewart said when he considered the hardness of the cuticle of these creatures, and the softness of their internal structures, he could only express his admiration at the skill with which Mr. Michael had overcome the difficulties in the way of such investigations.

Dr. G. C. Wallich read some "Notes on the Rhizopods," promising to continue the subject on a future occasion.

Mr. Crisp said that the question of symbiosis between animals and plants was one which was exciting a great deal of attention, and Dr. Wallich's remarks on the subject were of special interest.

The Meeting was then declared by the President special, in pursuance of notice given at the previous meeting; and it was then moved by Dr. Millar, and seconded by Mr. Crisp, that the bye-laws be suspended to enable the Council to nominate the President for election to a further term of office.

The proposal having been put to the meeting, was carried unanimously.

Mr. Crisp read a list of Fellows who had been nominated by the Council for election at the February meeting as Officers and Council for the ensuing year.

Mr. Badcock and Mr. Curties were elected Auditors of the Treasurer's accounts.

The following Instruments, Objects, &c., were exhibited:—

Mr. Beck—Short 1-6th in. Objective for Binoculars.

Mr. Bolton—*Rhipidodendron Huxleyi.*

Mr. Chadwick—*Bugula turbinata.*

Mr. Crisp—(1) Crouch's Portable Histological Microscope. (2) Miculicz's Stomach Microscope.

Mr. Groves—Martens' Ball-jointed Microscope.

Mr. Hardy—Chromatoscope.

Mr. J. Mayall, junr.—Tolles' Stage.

Mr. Michael—Slides illustrating the Anatomy of the Oribatidæ.

Mr. C. H. Stearn—Apparatus for Electrical Illumination by Incandescence.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. John E. Fawcett, Arthur S. Pennington, Samuel A. M. Satow, C. H. Trinks, Arthur W. Waters; and as *Ex-officio* Fellow, the President for the time being of the Essex Field Club.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY,

Containing its Transactions and Proceedings,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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

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

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., Lecturer on Botany at St. Thomas's Hospital, | F. JEFFREY BELL, M.A., Professor of Comparative Anatomy in King's College,

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

FELLOWS OF THE SOCIETY.

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

The Journal comprises:

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

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

Authors of Papers printed in the Transactions are entitled to 20 copies of their communications *gratis*. Extra copies can be had at the price of 12*s.* 6*d.* per half-sheet of 8 pages, or less, including cover, for a minimum number of 100 copies, and 6*s.* per 100 plates, if plain. Prepayment by P.O.O. is requested.

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

Published for the Society by

WILLIAMS AND NORGATE,

LONDON AND EDINBURGH.

THE ROYAL MICROSCOPICAL SOCIETY.

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

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

It consists of Ordinary, Honorary, and Ex-officio Fellows.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 10*s.* Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

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

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

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

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

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.

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BOTANY.

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MICROSCOPY.

ROYAL MICROSCOPICAL SOCIETY.

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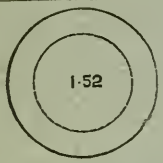
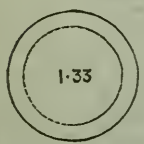
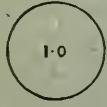
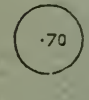
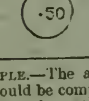
I. Numerical Aperture Table.

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

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

Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (⅛ in.) from 0·50 to 1·52 N. A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$).			Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
		Dry Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)			
	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1 316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

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

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

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

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

ins.	μ
$\frac{1}{25000}$	1·015991
$\frac{1}{20000}$	1·269989
$\frac{1}{15000}$	1·693318
$\frac{1}{10000}$	2·539977
$\frac{1}{9000}$	2·822197
$\frac{1}{8000}$	3·174972
$\frac{1}{7000}$	3·628539
$\frac{1}{6000}$	4·233295
$\frac{1}{5000}$	5·079954
$\frac{1}{4000}$	6·349943
$\frac{1}{3000}$	8·466591
$\frac{1}{2000}$	12·699886
$\frac{1}{1000}$	25·399772
	mm.
$\frac{1}{900}$	·028222
$\frac{1}{800}$	·031750
$\frac{1}{700}$	·036285
$\frac{1}{600}$	·042333
$\frac{1}{500}$	·050800
$\frac{1}{450}$	·056444
$\frac{1}{400}$	·063499
$\frac{1}{350}$	·072571
$\frac{1}{300}$	·084666
$\frac{1}{250}$	·101599
$\frac{1}{200}$	·126999
$\frac{1}{160}$	·169332
$\frac{1}{100}$	·253998
$\frac{1}{50}$	·507995
$\frac{1}{25}$	1·015991
$\frac{1}{20}$	1·269989
$\frac{1}{16}$	1·587486
$\frac{1}{15}$	1·693318
$\frac{1}{12}$	2·116648
$\frac{1}{10}$	2·539977
$\frac{1}{8}$	3·174972
$\frac{1}{6}$	4·233295
$\frac{3}{16}$	4·762457
$\frac{1}{5}$	5·079954
$\frac{1}{4}$	6·349943
$\frac{5}{16}$	7·937429
$\frac{3}{8}$	9·524915
	cm.
$\frac{7}{16}$	1.111240
$\frac{1}{2}$	1·269989
$\frac{9}{16}$	1·428737
$\frac{5}{8}$	1·587486
$\frac{11}{16}$	1·746234
$\frac{3}{4}$	1·904983
$\frac{13}{16}$	2·063732
$\frac{7}{8}$	2·222480
$\frac{15}{16}$	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd. =	·914392

Conversion of British and Metric Measures—*continued.*

(2.) Capacity.

Millilitres, &c., into Cubic Inches, &c.

millilitres.		cub. ins.
1		·061025
2		·122051
3		·183076
4		·244102
5		·305127
6		·366152
7		·427178
8		·488203
9		·549228
10	(1 centil.)	·610254
20		1·220508
30		1·830762
40		2·441015
50		3·051269
60		3·661523
70		4.271777
80		4·882031
90		5·492285
100	(1 decil.)	6·102539
200		12·205077
300		18·307616
400		24·410155
500		30·512693
600		36·615232
700		42·717771
800		48·820309
900		54·922848
1000	(1 litre)	61·025387

= ·035315 cub. ft.
= 1·760724 pints.
= ·220091 galls.

Cubic Inches, &c., into Millilitres, &c.

cub. ins.	millilitres.
·1	1·638662
·2	3·277325
·3	4·915987
·4	6·554649
·5	8·193311
·6	9·831974
	centilitres.
·7	1·147064
·8	1·310950
·9	1·474796
1	1·638662
2	3·277325
3	4·915987
4	6·554649
5	8·193311
6	9·831974
	decilitres.
7	1·147064
8	1·310930
9	1·474796
10	1·638662
20	3·277325
30	4·915987
40	6·554649
50	8·193311
60	9·831974
	litres.
70	1·147064
80	1·310930
90	1·474796
100	1·638662

277·274 (1 gall.) = 4·543584 litres.

(3.) Weight.

Milligrammes, &c., into Grains, &c.

milligrammes.		grains.
1		·015432
2		·030865
3		·046297
4		·061729
5		·077162
6		·092594
7		·108026
8		·123459
9		·138891
10	(1 centigr.)	·154323
20		·308647
30		·462970
40		·617294
50		·771617
60		·925941
70		1·080264
80		1·234588
90		1·388911
100	(1 decigr.)	
decigrammes.		
1		1·543235
2		3·086470
3		4·629705
4		6·172939
5		7·716174
6		9·259409
7		10·802644
8		12·345879
9		13·889114
10	(1 gr.)	15·432349
		oz. avoir.
100	(1 decagr.)	·352739
1000	(1 hectogr.)	3·527394
		lbs. avoir.
10000	(1 kilogr.)	2·204620

Grains, &c., into Milligrammes, &c.

grains.		milligrammes.
·01		·647989
·02		1·295979
·03		1·943969
·04		2·591958
·05		3·239948
·06		3·887937
·07		4·535927
·08		5·183916
·09		5·831906
·1		6·479895
		centigrammes.
·2		1·295979
·3		1·943969
·4		2·391958
·5		3·239948
·6		3·887937
·7		4·535927
·8		5·183916
·9		5·831906
1		6·479895
		decigrammes.
2		1·295979
3		1·943969
4		2·591958
5		3·239948
6		3·887937
7		4·535927
8		5·183916
9		5·831906
10		6·479895
		grammes.
100		6·479895
	avoir.	decagrammes.
437·5	(1 oz.)	2·834954
		hectogrammes.
7000	(1 lb.)	4·535927
		= ·453593
		kilogrammes.

III. Corresponding Degrees in the Fahrenheit and Centigrade Scales.

Fahr.	Cent.	Cent.	Fahr.
500	260° 0	100	212·0
450	232·22	98	208·4
400	204·44	96	204·8
350	176·67	94	201·2
300	148·89	92	197·6
250	121·11	90	194·0
212	100·0	88	190·4
210	98·89	86	186·8
205	96·11	84	183·2
200	93·33	82	179·6
195	90·56	80	176·0
190	87·78	78	172·4
185	85·0	76	168·8
180	82·22	74	165·2
175	79·44	72	161·6
170	76·67	70	158·0
165	73·89	68	154·4
160	71·11	66	150·8
155	68·33	64	147·2
150	65·56	62	143·6
145	62·78	60	140·0
140	60·0	58	136·4
135	57·22	56	132·8
130	54·44	54	129·2
125	51·67	52	125·6
120	48·89	50	122·0
115	46·11	48	118·4
110	43·33	46	114·8
105	40·56	44	111·2
100	37·78	42	107·6
95	35·0	40	104·0
90	32·22	38	100·4
85	29·44	36	96·8
80	26·67	34	93·2
75	23·89	32	89·6
70	21·11	30	86·0
65	18·33	28	82·4
60	15·56	26	78·8
55	12·78	24	75·2
50	10·0	22	71·6
45	7·22	20	68·0
40	4·44	18	64·4
35	1·67	16	60·8
32	0·0	14	57·2
30	− 1·11	12	53·6
25	− 3·89	10	50·0
20	− 6·67	8	46·4
15	− 9·44	6	42·8
10	− 12·22	4	39·2
5	− 15·0	2	35·6
0	− 17·78	0	32·0
− 5	− 20·56	− 2	28·4
− 10	− 23·33	− 4	24·8
− 15	− 26·11	− 6	21·2
− 20	− 28·89	− 8	17·6
− 25	− 31·67	− 10	14·0
− 30	− 34·44	− 12	10·4
− 35	− 37·22	− 14	6·8
− 40	− 40·0	− 16	3·2
− 45	− 42·78	− 18	− 0·4
− 50	− 45·56	− 20	− 4·0

IV. Refractive Indices, Dispersive Powers, and Polarizing Angles.

(1.) Refractive Indices.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air (at 0° C. 760 *mm.*)

(2.) Dispersive Powers.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air

(3.) Polarizing Angles.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp .gr. ·932)
Oil of turpentine (sp. gr. ·886)
Alcohol
Sea water
Pure water
Air

[Exact data for these tables are at present wanting.]

V. Table of Magnifying Powers.

OBJECTIVES.		EYE-PIECES.								
Focal Length.	Magnifying Power.	Beck's 1, Powell's 1, Ross's A	Beck's 2, Powell's 2, and Ross's B, nearly.*	Powell's 3.	Ross's C.	Beck's 3.	Beck's 4, Powell's 4, Ross's D.	Beck's 5, Ross's E.	Powell's 5.	Ross's F
		Focal Length.								
		2 in.	$1\frac{1}{3}$ in.	1 in.	$\frac{4}{5}$ in.	$\frac{2}{3}$ in.	$\frac{1}{2}$ in.	$\frac{4}{10}$ in.	$\frac{1}{3}$ in.	$\frac{1}{4}$ in.
		Magnifying Power.								
		5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	20	25	30	40
		Amplification of Objectives and Eye-pieces combined.								
ins. 5	2	10	15	20	25	30	40	50	60	80
4	$2\frac{1}{2}$	$12\frac{1}{2}$	$18\frac{3}{4}$	25	$31\frac{1}{4}$	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100
3	$3\frac{1}{3}$	$16\frac{2}{3}$	25	$33\frac{1}{3}$	$41\frac{2}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	133
2	5	25	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100	125	150	200
$1\frac{1}{2}$	$6\frac{2}{3}$	$33\frac{1}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	266
1	10	50	75	100	125	150	200	250	300	400
$\frac{8}{10}$	$12\frac{1}{2}$	$62\frac{1}{2}$	$93\frac{3}{4}$	125	$156\frac{1}{4}$	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500
$\frac{3}{4}$	$13\frac{1}{3}$	$66\frac{2}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$	$333\frac{1}{3}$	400	533
$\frac{2}{3}$	15	75	$112\frac{1}{2}$	150	$187\frac{1}{2}$	225	300	375	450	600
$\frac{1}{2}$	20	100	150	200	250	300	400	500	600	800
$\frac{4}{10}$	25	125	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500	625	750	1000
$\frac{1}{3}$	30	150	225	300	375	450	600	750	900	1200
$\frac{3}{10}$	$33\frac{1}{3}$	$166\frac{2}{3}$	250	$333\frac{1}{3}$	$416\frac{2}{3}$	500	$666\frac{2}{3}$	$833\frac{1}{3}$	1000	1333
$\frac{1}{4}$	40	200	300	400	500	600	800	1000	1200	1600
$\frac{1}{5}$	50	250	375	500	625	750	1000	1250	1500	2000
$\frac{1}{6}$	60	300	450	600	750	900	1200	1500	1800	2400
$\frac{1}{7}$	70	350	525	700	875	1050	1400	1750	2100	2800
$\frac{1}{8}$	80	400	600	800	1000	1200	1600	2000	2400	3200
$\frac{1}{9}$	90	450	675	900	1125	1350	1800	2250	2700	3600
$\frac{1}{10}$	100	500	750	1000	1250	1500	2000	2500	3000	4000
$\frac{1}{11}$	110	550	825	1100	1375	1650	2200	2750	3300	4400
$\frac{1}{12}$	120	600	900	1200	1500	1800	2400	3000	3600	4800
$\frac{1}{13}$	130	650	975	1300	1625	1950	2600	3250	3900	5200
$\frac{1}{14}$	140	700	1050	1400	1750	2100	2800	3500	4200	5600
$\frac{1}{15}$	150	750	1125	1500	1875	2250	3000	3750	4500	6000
$\frac{1}{16}$	160	800	1200	1600	2000	2400	3200	4000	4800	6400
$\frac{1}{17}$	170	850	1275	1700	2125	2550	3400	4250	5100	6800
$\frac{1}{18}$	180	900	1350	1800	2250	2700	3600	4500	5400	7200
$\frac{1}{19}$	190	950	1425	1900	2375	2850	3800	4750	5700	7600
$\frac{1}{20}$	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
$\frac{1}{25}$	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
$\frac{1}{30}$	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
$\frac{1}{40}$	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
$\frac{1}{50}$	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
$\frac{1}{60}$	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
$\frac{1}{80}$	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power, or respectively $\frac{1}{13}$ less and $\frac{1}{14}$ more than the figures given in this column.

Royal Microscopical Society.

MEETINGS FOR 1883,

AT 8 P.M.

1883.	Wednesday, JANUARY	10
„	FEBRUARY	14
	(Annual Meeting for Election of Officers and Council.)	
„	MARCH	14
„	APRIL	11
„	MAY	9
„	JUNE	13
„	OCTOBER	10
„	NOVEMBER	14
„	DECEMBER	12

THE "SOCIETY" STANDARD SCREW.

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

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

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

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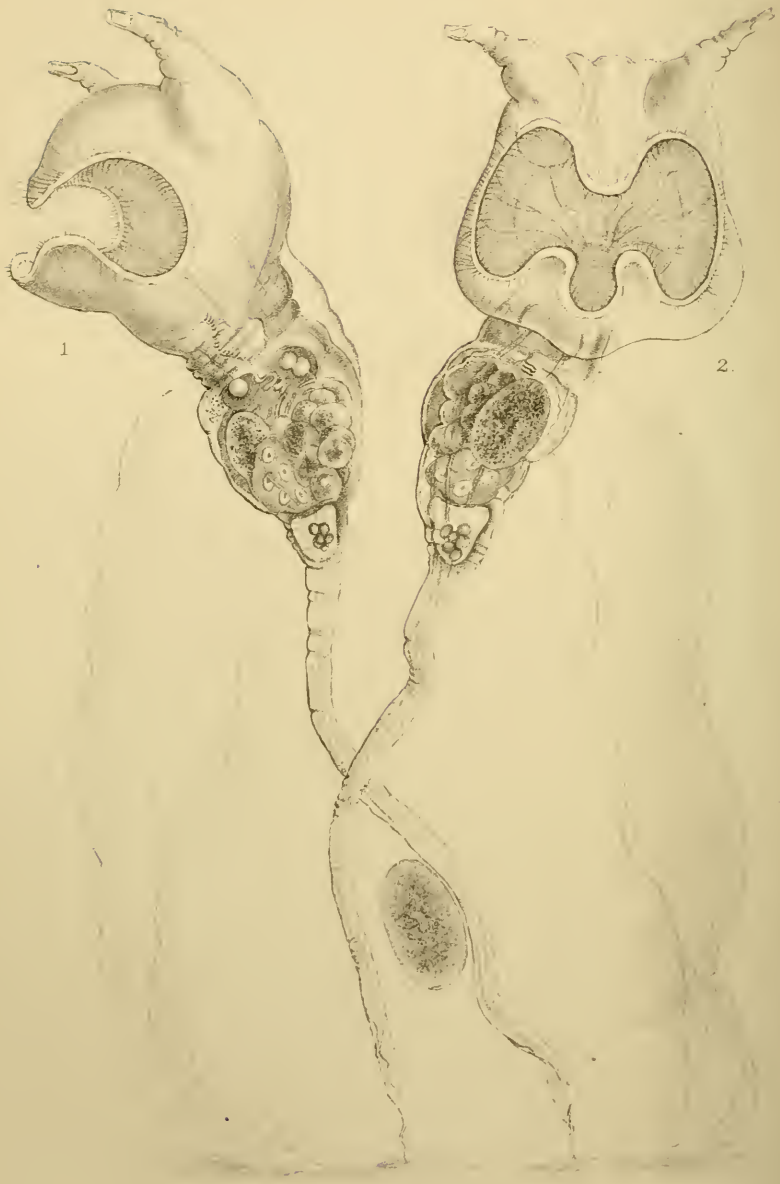

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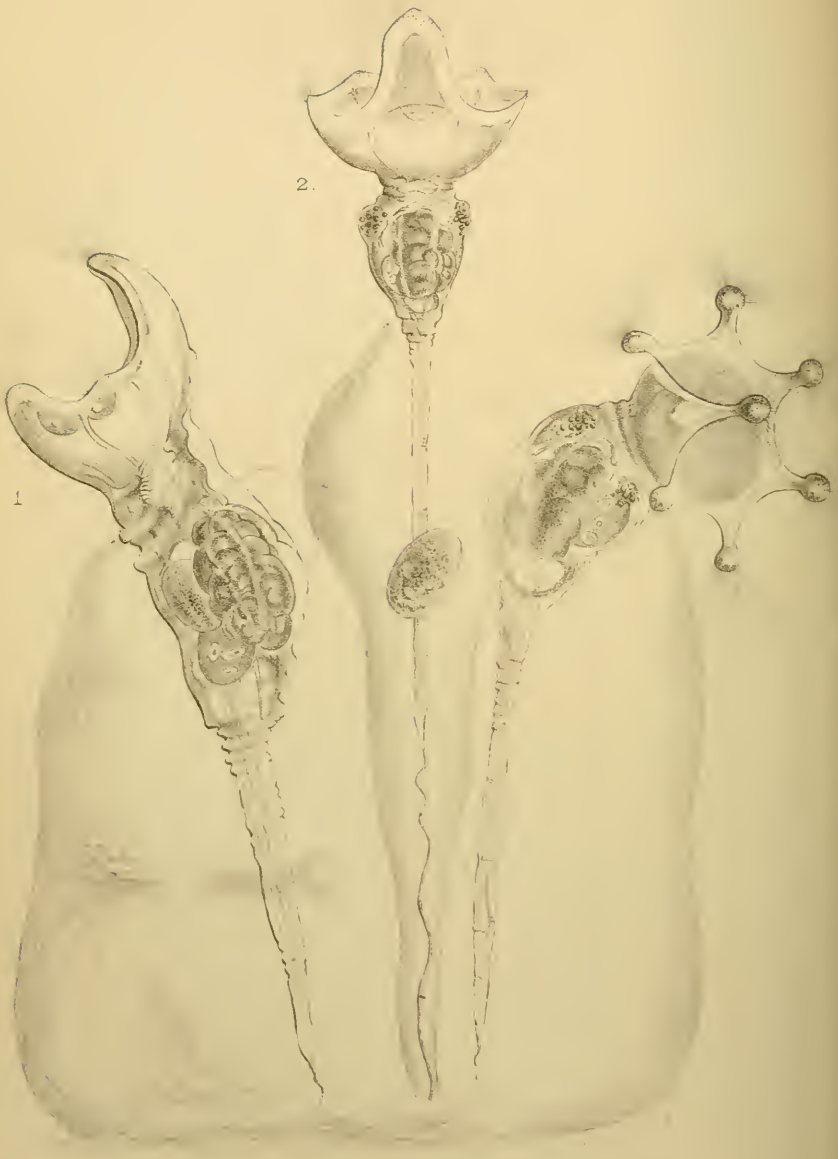
Floscularia Hoodii.



T. Hudson ad nat. del.

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1 Floscularia ambigua. 2. F. longicaudata.
3. F. regalis

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1883.

TRANSACTIONS OF THE SOCIETY.

IV.—*Five New Floscules; with a Note on Prof. Leidy's Genera of Acyclus and Dictyophora.*

By C. T. Hudson, LL.D., F.R.M.S.

(*Read* 14*th March*, 1883.)

Plates III. and IV.

Until quite lately there were only six known species of the genus *Floscularia*, viz.:—*F. ornata* Pallas, 1766; *F. proboscidea* Ehrenberg, 1832; *F. campanulata* and *F. cornuta* Dobie, 1849; *F. coronetta* Cubitt, 1869; *F. cyclops* Cubitt, 1871. To these have been added, during the last three years, no less than five other species, viz.:—*F. trifolium* Hudson, 1881; *F. regalis* Hudson, 1882; and *F. ambigua*, *F. longicaudata*, and *F. Hoodii*, which have not yet been described. Mr. Hood has also sent me from Dundee two specimens of what both he and I think is possibly another new species, called by Mr. Hood "the ringed Floscule," but whose extremely short hairs and impoverished lobes made me fear that it might only be one of the old species in bad condition. As, however, Mr. Hood has promised to look out for it this summer, I think it better to leave it for the present undescribed.

F. Hoodii. (Plate III. figs. 1, 2.)

This beautiful and strange creature was sent to me by Mr. Hood on the 25th December last year. He had just found it in a ditch on Tent's Muir in Fifeshire, along with *F. ambigua* and *Œcistes pilula*. It is the largest of all the rotifers, as adult specimens are quite 1-10th of an inch long from the top of the dorsal lobe to the extremity of the peduncle. Its great size and its possession (like *F. trifolium*) of only three lobes would make it sufficiently remarkable; but in addition to these peculiarities it has two extra-

ordinary flexible processes, perched one on each side of the summit of the dorsal lobe. I cannot yet hazard a suggestion as to the function that these processes perform.

No other species has anything in the least like them. They appear to be hollow, and to communicate with two sub-spherical spaces lying between the two surfaces of the dorsal lobe. Fine muscular threads pass down and across them, and the animal can contract and expand each independently of the other and throw them into all kinds of positions. The upper end of each seems to be separated partly from the remainder by a constriction from which a muscular thread runs down to the base; but though I have tried many objectives and every kind of illumination, I have failed to see the slightest trace of setæ in them. Besides, if these were two antennæ, they would be in a unique position; all other Floscules have their pair of setæ-bearing antennæ on their sides below the trochal disk, while the dorsal surface carries a solitary setigerous eminence on the medial line.

Mr. Hood tells me that he has seen both a young and an adult specimen of *F. Hoodii* discharge through these processes granular matter which gathered round their free extremities, and which the creature got rid of with difficulty.

Frequently when the animal is fully protruded from its case, one of the processes is invisible, having been permitted to collapse as it were on to the dorsal lobe. Then the upper end of the visible process may be seen to move so as to form almost a right angle with the lower portion; or again, the whole of the one process will be slowly lowered on to the dorsal lobe while the other is gradually distended and raised.

The thickened rim of the three lobes carries a double fringe of setæ, set just as they are in *F. trifolium*, the larger row stretching outwards and the smaller inwards; and I have on several occasions seen a rapid flicker run all along the smaller setæ, not constant or regular enough to produce the phenomenon of "rotation," but still a very obvious motion of each separate seta. The gape of the mouth-funnel alters constantly, now opening in the characteristic way shown in the figure, plate III. fig. 2 (which is the ventral view) and then closing by means of its many muscular threads, so as to reduce the aperture to a mere slit, or even to shut it up in puckers. If the animal is so placed that the line of sight strikes the middle of the dorsal surface obliquely, it will be seen that a nearly transparent ridge or buttress runs up from either side of the body to the back of the dorsal lobe, ending at the base of the process. One of these is shown in the side view (plate III. fig. 1). Between these two ridges there is a deep hollow, bounded above by the dorsal lobe and below by the rounded surface of the body. At the lowest portion of this hollow, and

close to the buttress ridges, are the two eyes. It requires a little care and patience to get a sight of them, as they are of only a pale pink and are frequently obscured by other parts of the animal.

It is easy to see the true rotatory organ which consists, as usual, of a ciliated horseshoe-shaped rim at the base of the mouth-funnel and on the ventral side of it, and which is continued in two long curved lines down the vestibule to the lips. The contractile vesicle is unusually large and plain, and in all the specimens which I have seen it contained a cluster of yellow globules, which appeared black by transmitted light.

As Mr. Hood asked me to name this rotifer, I thought I could not do better than name it after himself, not only because its very shape suggested it, but also because it seemed only right that of the five very remarkable rotifers that Mr. Hood has discovered, at least one should bear his name.

F. ambigua. (Plate IV. fig. 1.)

F. ambigua was discovered by Mr. Hood on Sphagnum in a mossy pool on Tent's Muir near Luchars in May 1881, and by Mr. Bolton in September 1881 near Birmingham. Since then Mr. Hood has found it in Loch Rea near Blairgowrie Perthshire, on a coarse species of Chara, along with *Œcistes Janus*.

This is the least elegant of all the Floscules; it is broad and stumpy, and its trochal disk appears at first sight to have but three lobes. There are however besides the three larger lobes two slightly raised setigerous eminences on either side.

Like *F. Hoodii* it has two semi-transparent dorsal ridges running up from the body to the dorsal lobe. These indeed exist in some degree in all Floscules, but are unusually prominent in the two above-named species.

Its body is generally thrown into coarse transverse folds at the lower extremity, so as to make quite a well-marked separation between itself and the foot, the latter appearing to possess but half the width of the body at the point where it joins it. At various points across the body, and especially round the base of the mouth-funnel, there are usually several thick corrugations obscuring the internal structure. The creature's habits are curious, and have been so well described by Mr. Hood in a communication to myself, that I cannot do better than give his own words:—

"This Floscule is not a beauty, but what it wants in grace it gains in interest, for it is most amusing to watch it feeding. As soon as it has fully expanded its large head, infusoria of various species may be observed to be drawn swiftly down the large cavity formed by the lobes. The inward-setting current thus formed by the cilia at the base of the cavity seems to be stronger in *F. ambigua* than

in the other Floscules, as large animalcules, such as *Kolpoda*, *Paramecia*, and even free-swimming rotifers will often fall victims to this big burly and voracious creature. It has an insatiable appetite: I have frequently seen the young of *Œcistes pilula* and *Œ. umbella* devoured by it, the young of the large rotifers making even less resistance than the infusoria.

At first I thought that *F. ambigua* was wholly carnivorous, as I had seen it reject vegetable organisms, but I have since often seen it devour young *Volvox globator*.

When once it has got a victim within its great mouth-funnel there is no possibility of its making its escape, although with a full stomach *F. ambigua* seems inclined to play with its prey as a cat would with a mouse, allowing it to swim about within the funnel and to try to escape over the margin. Whenever the animalcule approaches the setigerous rim a sharp stroke from one or more setæ drives it back into the funnel.

I have seen the attempt to escape repeated again and again, but always with the same result; in no single instance have I ever witnessed the escape of a captive. No one would credit the voracity of this Floscule who had not watched it. I have seen one eat in half-an-hour no less than twenty-four live infusoria of various sizes; it only gets a rotifer or a young *Volvox* now and then as a change of diet.

F. ambigua is by no means a delicate rotifer, for it can be kept in a live-trough in good health with very little trouble during the whole period of its life by merely furnishing it with a few drops of water from an aquarium daily.

It deposits from two to five female eggs, which take about six or seven days to hatch. The young female when hatched is furnished vith very delicate vibratile cilia on the head, and with two red eye-spots. The frontal lobes are entirely absent. Propelled by the frontal wreath of cilia the young Floscule swims rapidly and gracefully through the water for about two or three hours, poking into corners and crannies in quest of a fitting place of abode.

It selects for its future residence either the axil of the plant or the concave side of a leaf. It seems to prefer an ambush to an exposed spot, for I have never met with it on the point of a leaf. The young Floscule when first fixed on the leaf is so like a young *Stentor* that it might easily be mistaken for one; but in a short time a collar begins to develope immediately under the wreath of frontal cilia; and, as it rises above the wreath, the lobes develope from the collar, increasing in size as the animal grows. If fed well, the young animal arrives at maturity about the twenty-fourth or twenty-fifth day, and will then deposit eggs, but it never ceases to increase in size till shortly before its death. Its whole lifetime in a

trough, if carefully attended to, is from forty to forty-six days, but of course it may live longer in its natural habitat. When old age arrives it does not contract its lobes closely if alarmed, and it is slow in expanding them or in contracting its peduncle. At last it ceases either to close the lobes or contract the peduncle, its setæ fall off, the internal organs cease to move, and it dies with the lobes fully expanded.

In two hours after death it is surrounded by swarms of infusoria, and in a few hours more these leave not a vestige of it, the Floscule having in its turn been devoured by the very prey on which it used to feed.

I had the good fortune to witness the hatching of two males of *F. ambigua*—they were produced as usual from smaller and rounder eggs than those of the females. The digestive organs and mastax were wanting, and the anterior portion of the body was transparent, bearing a wreath of long vibratile cilia and two red eye-spots; the posterior portion contained the sperm-sac, with a tube leading towards the foot. It is a most restless creature, so that it is difficult to get a good observation of all its parts.

F. longicaudata. (Plate IV. fig. 2.)

F. longicaudata was discovered by Mr. Hood in a pool on Tent's Muir in May 1881, and in Loch Rea in July and August of the same year. Although a rather rare rotifer, it is more social than *F. ambigua*, forming small colonies of half-a-dozen individuals or more.

It differs also from *F. ambigua* in its choice of habitat, for it prefers to perch itself on the exposed end of a leaf; whereas *F. ambigua* forms its tube in the axils of the plant it is on, or on the concave side of the leaf. The creature's chief peculiarity is the very long non-retractile peduncle in which the foot ends. This peduncle exists in all Floscules, but is usually not more than 1-15th or 1-20th of the length of the foot; in *F. longicaudata*, however, the peduncle is often 1-3rd of the length of the foot. It is a thin transparent thread, and is frequently thrown into graceful curves and coils. The lobes of the mouth-funnel are usually more angular than those of any Floscule I am acquainted with; the specimen from which the figure was drawn showed this peculiarity in a marked way. The dorsal lobe is as usual the largest; and the two ventral lobes are larger than the two side ones, which indeed are at times quite insignificant, though their presence is always indicated by the pencils of radiating setæ. All the specimens which Mr. Hood sent me had neater and more compact tubes than those of other species; but, as they also differed considerably from each other, this may have been accidental.

F. regalis. (Plate IV. fig. 3.)

Mr. Bolton sent me this remarkable rotifer last September. Its trochal disk is quite unique, for hitherto all the known species of Floscules have had either five or three setigerous lobes. It is true that Ehrenberg credits his *F. proboscidea* with six lobes and a flexible open-mouthed tube rising from the midst of them, all crowned with setæ, and says that he has found *F. ornata* sometimes with five lobes and sometimes with six; but hardly any other observer has seen a six-lobed Floscule.

Mr. Slack, in 'Marvels of Pond Life,' says that he has met with *F. ornata* bearing six lobes, with "six hollow fan-shaped tufts [of setæ], one attached to each lobe." Dr. Dobie also states that a friend of his, viz. Mr. Hallett of the Museum of the Royal College of Surgeons, had found *F. ornata* "with a six-lobed rotatory organ." Such precise statements ought perhaps to settle the question; but Mr. Slack goes on to say that "for a long evening only five could be discerned in the specimen now described, but the next night six were apparent without difficulty or doubt," and he attributes the discrepancy to the different positions which the Floscule held.

It is quite possible then that Mr. Slack had *F. regalis* under observation, and not *F. ornata*, and that the creature's varying positions hid now one, now both, of the smaller lobes. Ehrenberg's *F. proboscidea* may have been also the same creature; for though Ehrenberg describes it as having a flexible snout-like tube with an open mouth rising in the midst of the lobes, his figure shows merely a well-developed dorsal lobe with a clear space near the summit between its two surfaces. This clear sub-spherical space exists in several species of Floscule, and Ehrenberg seems to have mistaken it for the mouth of his "flexible tube."

His figure bears rather the broadly-curved lobes of *F. campanulata* than the knobbed ones of *F. regalis*, but he distinctly says that the lobes were knobbed. Possibly there may yet be another species of seven-lobed Floscule with flattened lobes; at any rate, I think it not unlikely that Ehrenberg had some seven-lobed Floscule when he described *F. proboscidea*.

The mouth-funnel of *F. regalis* is a deep cup with a nearly circular rim, from which project four knobbed processes on the ventral side, dividing that half of the rim into three equal spaces. They curve slightly outwards and widen as they approach the rim, so that their bases unite, and give to the edge of the cup a hexagonal appearance.

On the dorsal surface rises a large triangular knobbed lobe bearing on each side of its base two very short recurved knobbed processes. All the seven knobs carry pencils of long radiating setæ.

It is worthy of remark that Cubitt's *F. coronetta* carries two small pencils of radiating setæ near the base of the dorsal lobe.

In the specimens that I have seen it was easy to make out both the eyes and horseshoe-shaped row of vibratile cilia at the mouth-funnel. None of the specimens exceeded 1-50th of an inch in length.

The ten (or eleven) species of the genus *Floscularia* may be arranged as follows:—

* *Lobes without knobs.*

With 3 large lobes.	Not separated by minute ones	Two processes on dorsal lobe	*F. Hoodii.*
		No processes	*F. trifolium.*
	Separated by two minute ones		*F. ambigua.*
With 5 lobes	Lobes broad, depressions distinct	Peduncle short	*F. campanulata.*
		Peduncle very long	*F. longicaudata.*
	Lobes round and small, depressions indistinct		*F. Cyclops.*

** *Lobes knobbed.*

With 5 lobes	Lobes triangular	Flexible process on dorsal lobe	*F. cornuta.*
		No process	*F. ornata.*
	Lobes linear		*F. coronetta.*
With 7 lobes			*F. regalis.* and perhaps *F. proboscidea.*

I find that I have omitted to mention that Mr. Hood found on one or two occasions a Floscule inhabiting a trumpet-shaped tube, and that he thinks this also is a true species new to science. I have not had the good fortune to see the rotifer, as it died in the transit, but I have great hope that neither this species nor "the Ringed Floscule" will escape Mr. Hood's energetic search and keen sight during the coming summer.

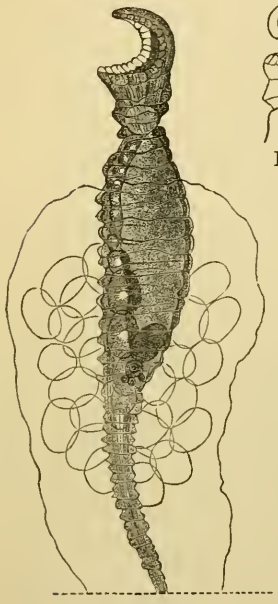
Note on Prof. Leidy's genera of Acyclus and Dictyophora.

Professor Joseph Leidy has lately discovered and described * a very curious new rotifer, which ought, I think, to be placed near the Floscules. He says, "While examining some *Plumatella diffusa* from the Schuylkill river below Fairmount Dam my attention was attracted to several groups of *Megalotrocha alba* attached to the tubes of the former, and surrounding another animal of strange and novel character. This, on examination, proved to be a remarkable rotifer without rotary organs. . . . This new rotifer I propose to name *Acyclus inquietus* (fig. 31), from its being destitute of wheels or ciliated disks, and from its apparently restless habit. It is considerably larger than *Megalotrocha*, measures nearly a half line long, and can be readily distinguished in groups of the latter with

* Proc. Acad. Nat. Sci. Philad., 1882, pp. 243–50 (1 pl.).

the naked eye. It was observed in eight instances, in each alone, and always inclosed in a group of *Megalotrocha*, above which, from its greater size, it towered like a giant in a crowd. . . . *Acyclus* is translucent whitish, with the thicker part of the body yellowish or brownish, due to the colour of the capacious intestine shining through the integument. It was difficult to obtain a clear and accurate view of the exact mode of attachment and the internal structure of the animal, from its incessant motions, its becoming wrinkled in contraction, and from its being obscured by the surrounding bunch of *Megalotrocha*. . . . The head is in the form of a cup prolonged at the mouth into an incurved beak. It is retractile, protrusile, contractile, and expansile. When protruded and expanded the mouth gapes widely, and the beak becomes more extended, but always remains incurved. The mouth is bordered by a delicate membrane extending to the rounded end of the beak, and presenting a festooned appearance. . . . In contraction of the head or oral cup it is reduced to half the bulk of its expanded condition, while the mouth is constricted and the beak is rolled in a single spiral inwardly, as seen in fig. 32. The extension of the head below forms a narrowed and transversely wrinkled neck, which expands into the body. The expansion and contraction of the head appear to be due to the flow of a milky liquid between the cœlum or body-cavity and intervals in the walls of the oral cup or head. The retraction of the latter is produced by longitudinal muscles, which may be seen in the wall of the cup extending from the wall of the body just below the neck to the festooned membrane bordering the mouth . . . The oral cavity converges in a funnel-like manner to a pouch occupying the neck. The pouch is seen to contract and expand from time to time, but it was indistinctly defined. At the bottom of the pouch there is a small mastax, or muscular pharynx, provided with minute jaws." Professor Leidy goes on to say that the jaws have a parallel series of about twenty teeth, that the tail is occupied with retractor muscles extending from the walls of the body, that the interval between the stomach

Fig. 31.



Acyclus inquietus.
Entire animal.

Fig. 32.

Head.

and wall of the body is occupied by the ovaries and ova, and that in the vicinity of the lower extremity of the stomach there were several yellow spherical balls. Most of the individuals observed were without a case, but in two instances the animal was included in a "copious colourless gelatinous sheath," and had also adherent a large bunch of eggs, in one of which were as many as fifty.

It is clear from this description that *Acyclus inquietus* resembles the Floscules in many respects. Its "oral cup" with the "incurved beak" may be fairly said to be the buccal funnel of a Floscule reduced to the possession of *one* lobe, viz. the dorsal one. The "oral pouch" in the wrinkled neck is the counterpart of "the vestibule" of the Floscules, just above which, and generally hidden by the wrinkles, lies the true rotatory organ, and at the base of which is the true mouth. In both genera there are minute jaws just below the vestibule; in both the buccal funnel is retracted by longitudinal muscles, which take their origin in its outer rim, spread over its wall, and pass down the body right to the end of the peduncle; and in both the buccal funnel is expanded by means of a fluid driven into spaces between the cuticle and dermis. To complete the points of resemblance *Acyclus* is attached when adult, and is occasionally surrounded by a gelatinous sheath, in which lie the extruded eggs.

The main differences are the entire absence of setæ from the rim of the buccal funnel, the apparent lack of any vibratile cilia, the edging of the buccal funnel with a delicate membrane, and the presence of about twenty parallel teeth in the jaws.

The first of these differences is not one of much importance, for the length of the setæ differs remarkably in the various species of Floscules. In some—as in *F. ornata* and *F. campanulata*—they extend to quite the length of the animal's body, while in *F. Hoodii* they are hardly half the width of the buccal funnel; and Mr. Hood thinks he has seen on several occasions a new species in which they are shorter still. The membranous edge of the buccal funnel and the numerous teeth in the jaws clearly mark off *Acyclus* from *Floscularia*, but the still more striking difference, viz. the absence of a rotatory organ, may, I think, be only an apparent one. As I have already remarked, this organ consists of a ciliated horseshoe-shaped ridge on the ventral side of the buccal funnel, just where it joins the vestibule, and it is in some species continued down the vestibule in two lines towards the mouth.

In most of the species it can only be seen in some fortunate position of an unusually transparent specimen; but in *F. trifolium* and *F. Hoodii* it is quite easy to make it out. Now, considering the difficult circumstances under which Professor Leidy saw *Acyclus*, its restless habits, and its thickly-wrinkled cuticle, it is not impossible that this rotatory organ may have been overlooked.

That however does not seem probable in the case of another very strange rotifer, described and figured by Prof. Leidy in the same paper, and which he discovered and described in 1857, giving it the name of *Dictyophora*. As the animal is attached by a sucking disk, is almost motionless, very transparent, and free from wrinkles, the rotatory organ would not have escaped notice had it been present; yet neither Prof. Leidy nor Mr. S. A. Forbes, who probably described the same creature under the name of *Cupelopagus bucinedax*,* could detect any vibratile cilia. Prof. Leidy says that "*Dictyophora* is oval or ovoid, with the narrower pole corresponding with the position of the mouth, truncated, and it adheres by a small disk or sucker to one side of the broader pole. . . From the truncated extremity of the body the animal projects a capacious delicate membranous cup, forming more than half a sphere, and more than half the size of the body. At will the cup is entirely withdrawn into the body, and the orifice of this becomes contracted and puckered into folds radiating from a central point or orifice. . . The prehensile cup opens into a capacious sac, which is within the body and occupies a good portion of its upper half. The sac at bottom communicates with a mastax nearly central in position. . . The mastax opens into a capacious sacculated stomach. . . Numerous ova in all conditions, from the earliest to those which contain fully developed embryos, occupy the body-cavity of *Dictyophora*, sometimes in such numbers as to obscure everything else from view."

This most curious animal still retains some likeness to the Floscules in spite of the degradation of so many parts. The "membranous edging" of *Acyclus* has here developed at the expense of the buccal funnel, which it has entirely supplanted, and the peduncle has shrunk down to a mere sucking disk; but the "capacious sac," which lies between the mouth and the mastax, is the exact counterpart of a Floscule's "crop" in which its food accumulates after slipping down the tube hanging from the mouth, and before passing the mastax into the stomach. On the other hand the mastax with its five teeth in each jaw, and also indeed the position of the sucking disk (which is on the side of the ventral surface towards its lower end instead of at its extremity) are decided points of difference, to say nothing of the complete absence of buccal funnel, lobes, setæ, and vibratile cilia.

Prof. Leidy quotes Cohn's remark that a rotifer without a rotatory organ would be a "rude abnormity" (*eine schroffe Abnormität*); and indeed it does seem at first sight a very nice question whether an animal that has no rotatory apparatus can be a rotifer. Yet *Stephanoceros* and all the Floscules are pretty nearly in this condition; for their generally motionless setæ have

* See this Journal, ii. (1882) p. 625.

no sort of pretension to be considered as forming a rotatory organ, and their vibratile cilia are so few and inconspicuous that their loss alone would not be reason enough for removing these two genera from among the rotifers. It is among the *Notommata* and their allies that we find the most numerous instances of the degradation of the trochal disk, especially among the parasitic species; and this, as might be expected, is often accompanied by the degradation or loss of other characteristic organs, until at length in Gosse's *Taphrocampa* we arrive at a larva-like creature destitute alike of gastric glands, vibratile tags, contractile vesicle, and trochal disk; its sole connection with the Rotifera being its characteristic mastax. Prof. Leidy suggests that perhaps *Taphrocampa* may have a rotatory apparatus, which was concealed when Gosse observed it, just as it was in the case of *Lindia torulosa* when Dujardin discovered it. This of course is possible; but even the possession of such ciliated appendages as those of *Lindia* would leave *Taphrocampa* stripped of the greater part of a rotifer's characteristics.

In passing under review such a series of creatures as *Lindia torulosa*, *Albertia vermiculus*, *Notommata Werneckii*, *Balatro calvus*, *Seison Grubei*, and *Taphrocampa annulosa*, it naturally occurs to one that, in the case of animals departing so widely in other respects from the rotiferous type, the further loss of a few vibratile cilia would not seriously affect their classification; but if Cohn merely meant that it would be a "rude abnormity" for a rotifer to possess all the chief characteristics of its class, the mastax, vibratile tags, contractile vesicle, &c., and yet lack a trochal disk, he is certainly right; for no such rotifer is as yet known. But Prof. Leidy's interesting discoveries make us acquainted with at least two genera that are perilously near such an abnormal state of things: for, although no mention is made of the contractile vesicle and vibratile tags of *Acyclus* and *Dictyophora*, it is obvious that they may exist, as it would be at all times a very difficult thing to see them.

V.—*The President's Address.* By Prof. P. Martin Duncan, M.B. Lond., F.R.S.

(*Annual Meeting*, 14*th February*, 1883.)

Every Fellow of this Society who has attended the evening meetings during the last twelve months, must have been struck with the very practical nature of our proceedings, and that the observations made, and the apparatus exhibited and described on those occasions, indicated a growing desire for the perfection of the Microscope. At the same time it must have been evident that the application of the instrument to its proper purposes is open to many sources of error, and that there is an amount of intelligence and knowledge required in the management of the Microscope, which is the result of much labour, thought, and experience. Common sense might tell everybody this, but it sometimes happens that when a man has invested a certain number of guineas in an instrument, he imagines he is correspondingly endowed with the abilities of a microscopist in the true sense of the term. On the other hand a very large number of able men become possessed of instruments humble in appearance and not costly in any sense, and they rest satisfied that a Microscope is a Microscope, and believe therefore that they see the true invariably. One of the benefits of belonging to our Society is the opportunity of seeing objects properly shown by the ablest manipulators, and of hearing communications on the imperfections and corrections of the instrument, and it would be well if our list, full as it is, were crowded by those scientific men who constantly use the Microscope in original research in biology. A considerable experience impresses me that the majority of students, and not a few professors, not only use indifferent instruments, but also carefully avoid all those practices which we know are absolutely necessary for correct microscopy. A thing is seen, therefore it must be real; one man sees a spiral line, another a circle, another a series of dots, using the same object and different Microscopes. They describe and debate and each is self-satisfied. Yet all the while had they had a master in microscopy, their differences could be terminated.

We constantly read of wonderful researches involving great dexterity of preparation, tedious dissection, and elaborate mounting, consummated at last by a description of what is seen under a Microscope. Some one else follows the subject and cannot see what the previous observer has drawn. Here the difference clearly relates to the Microscope, and therefore it is worth while to pass in review and remark upon some of the results of the work of our Society during the past year, so that workers may be stimulated

to care more for the instrument than most of them have done hitherto.

Most of the inexperienced, and not a few experienced Microscope-possessors illuminate, when transmitted light is used, in a manner exactly opposite to that which they follow with the unaided eye. They get all the light possible from a reflecting surface. Common experience teaches us that there is an exact relation between the possibility of seeing the half and lower tints and of searching the depths of shadows, and the intensity of the light entering the eye. It tells us that only outlines are well shown as sky lines, or when a brilliant light is passed around and through the body examined.

Yet a pleasant evening with the Microscope generally means a painful time for the eye. A good glare of light, thanks to lamp, condenser, mirror, and forgotten diaphragm, appears to be almost invariably a desideratum to the beginner. Experiences teaches, however, and the advanced microscopist never uses more light than is absolutely necessary, and increases and diminishes the illumination during the careful observation of an object, not only by employing a less intense source of light, but also by using diaphragms of different sizes.

The employment of different tints of coloured light, especially pale blue and green, gives a wonderful relief to the eye when transmitted light is used with or without a dark black ground. In examining siliceous organisms the relief is great; but practice follows theory in rejecting purples and allied tints, the more delicate shades of which are not readily distinguished by the eye. One of our Fellows has lately introduced a very simple apparatus which enables a succession of colours or a group of tints to be used, and there is no doubt that it will be much valued.

The method of application of the electric light to the Microscope, and the beautiful apparatus which has been exhibited before the Society, must have impressed everybody that it will be the light of the future. The brilliancy and coolness of the light, and the possibility of directing it readily in investigating opaque objects with low and very high powers, commend the method of illumination. It will be of great use in investigating objects by means of high powers with reflectors within objectives, and in moving around opaque objects which are well in focus under low powers, and whose surfaces are difficult to define under ordinary circumstances in a short time and with the usual appliances. We may expect that on all occasions when there is an exhibition of a considerable number of Microscopes, the electric light will be used, and the dangerous and offensive rock-oils abolished.

Since microscopy has been extended to the examination of sections of rocks composed of different minerals, the truth that some can be roughly distinguished by their dichroism under the

polarizing ray, the analyser not being used, has become apparent. The polarizer is also useful in another manner. Researches have been undertaken to examine into the influence of the polarizing ray upon substances which may or may not give the usual phenomena under the analyser. Polarized light carefully manipulated is very useful in examining thin sections of corals which are made up of closely placed fusiform and long alternating prisms, with geometrical prisms of carbonate of lime in planes one over the other, and often radiating from different points. Shadow and high light succeed when the Nicol is rotated, and minute details become apparent which are not seen, or are only feebly defined, by ordinary light reduced in its intensity to that of the polarizing ray by the use of diaphragms.

Some time since, in investigating the structure of a fossil which was composed of close radiating and occasionally inosculating tubes with very thin walls and a distinct lumen, all mineralized with calcite in the glassy, non-crystalline form commonly seen in fossils where there is much space unoccupied by structure, the polarizing ray certainly made the tubes more distinct than the ray reflected from the mirror alone, and by rotating the substage Nicol, the position of certain tubes which were invisible before could be ascertained; that is to say, dark lines appeared limiting tubes which were invisible under ordinary illumination.

The application of the whole polarizing apparatus is very useful in working at the minute superficial structures made up of thin and highly refractive plates of organic carbonate of lime. The glare of light under ordinary illumination and even when the polarizer only is used, prevents the true surface being focussed, or if it is fortunately hit upon, it is more or less invisible. But the analyser being placed across the direction of the polarizing ray the true surface can be found by the definition and distinctness of the clear colours and the intermediate lines. Take away the analyser, and often new structures appear to the eye. As a matter of practice I find that this method is exceedingly useful.

Many a possessor of a valuable instrument has been discouraged at the outset of his work by the want of definition of his high powers and by the presence of glare in his field, and even of a spot where nothing is visible. He has everything at his command in the way of the instrument, or nearly so. But he works in a room full of diffused light, and probably uses no diaphragm or cap to his elaborate condenser. He suffers from reflection in many directions. One of the simplest troubles of the young worker arises from his not preventing the access of light upon his object when he is working by transmitted light, and the failure when employing high objectives relates to similar causes and requires similarly simple remedies.

There certainly is a cause of error latent in many mirrors, and many Microscopes of the small type have their reflectors so made as to reflect light quite as much from the brass edge as from the glass. Carefully examined they are found to be badly silvered, and the result is unequal light. There is no doubt that many of our best practical microscopists use direct light whenever they can; and it is equally true that mirrors and their reflected light are often very difficult to manage. Perhaps the re-introduction of plane silver mirrors will relieve workers from some trouble.

It is almost a presumption to remind those whom I have the honour to address that there is no gain by amplifying at the expense of definition, and that the short eye-piece with its high power searches out and makes the errors of the objective manifest. But it may be asserted that comparatively few microscopists select that eye-piece which produces the best results in combination with a given objective. The medium eye-piece is almost invariably used.

Now there is, as we hope to hear clearly demonstrated shortly by Professor Abbe, a necessity for balancing the performance of the Microscope between the objective and eye-piece, in a manner which is not simply empirical.

There ought to be (the length of the tube of the Microscope being invariable) a positive relation between the performances of the upper and lower system of lenses, and therefore between the magnifying power of the eye-piece and the numerical aperture and amplification of the objective. Experience proves that it is not the longest eye-piece or a regulation medium one which will always produce the best results with a given objective, and that it by no means follows that the eye-pieces supplied with a Microscope will suit the objectives which may be added from time to time, or even those originally put up with it.

Without carrying this subject further I might state that in my own case a medium and a long eye-piece of excellent workmanship, and which usually give excellent results, do not evolve the qualities of a Zeiss objective (E) which is of a moderate numerical aperture, so well as one of slightly higher power and shorter tube than the medium one just noticed. But this eye-piece does not do the same service when a Gundlach water-immersion (1-12th in. focus) is used, and the longest eye-piece then answers, although the objective was made for the length of tube generally used in this country.

Circumstances have brought me in contact with cheap Microscopes, and certainly whilst it may be said that some of the objectives are fairly good, the eye-pieces are on the miserable "par" with the rest of the apparatus. I cannot avoid believing that during the next few years attention will be paid to increasing the merits and adaptability of eye-pieces whatever may be their special character.

It is pleasant in these days of free thought to have the mind, which has got rather into the "rest and be thankful" mood, suddenly awakened by the jarring sound of such assertions as those made with regard to the binocular Microscope by Professor R. Hitchcock. "The stereoscopic effects, while not of great practical importance, as already stated, certainly render many objects more attractive to look at. For this reason a Microscope for the entertainment and instruction of friends should certainly be a binocular."*

The Professor states that there is no advantage in a binocular Microscope in studying the form of objects, but the value of this opinion is shaken when he asserts, in the same sentence, that the appearance of relief the binocular gives is not necessary to enable us to form a correct idea of the true state of objects in which the appearance of relief is most striking.

He qualifies his opinion, however, by writing:—"It is true that the binocular does reveal more of the form of an object at the first glance than the monocular, but it is a matter of experience that those who only use one eye in microscopical work, never make the mistake of supposing that an object is merely flat because it seems to be so. A few turns of the focussing screw soon give a correct idea." The Professor considers that the value of the binocular is restricted to the comforts of vision. I do not think that these views will receive acceptation in the old world; on the contrary, it is to be hoped that the late admirable adaptation of an objective of high power by a distinguished Fellow of this Society to the binocular will pave the way to still more advantageous developments of the binocular system.

Constantly using objectives of low power in examining objects of natural history, naturalists find that the binocular enables them to decide at once whether a series of markings are elevations or depressions or alternate elevations and depressions. With the monocular they must shift the illuminating beam as well as alter the focus, so that they can see the truth, revealed at once, by the other instrument.

In the address which I had the honour of delivering to you last year I remarked upon the comparative values of object-glasses with high and low numerical apertures, and I took pains to defend the employment of lenses with wide apertures in examining minute objects, and also to state that both kinds of objectives are necessary for investigating into the structure of minute objects. I suggested what has commended itself to every advanced microscopist for years past, that an observer should provide himself with both classes of objectives, and that he should use those with a moderate aperture for common and preparatory work, and those with a high numerical aperture for subsequent and careful examination.

* Amer. Mon. Micr. Journ., iii. (1882) p. 417.

Subsequently Professor Abbe sent a communication to our Journal which pretty well sets at rest the former debates about the value of objectives with a high numerical aperture, and thoroughly defines the relative value of the two classes of lenses. He states "the obvious inference . . . is that the widest possible apertures must be used for the observation of objects or structures of very minute dimensions, low and moderate apertures for relatively large objects." The ordinary microscopical investigation of the structures of animals and plants can be best done with lenses of low numerical aperture. But when minute structures require to be accurately defined there must be a wide aperture and also a corresponding amplifying power. Deficiency of power renders a high numerical aperture useless, and therefore wide apertures are necessary when a high amplification is required. Professor Abbe's conclusion regarding the practical value of the two classes of objectives is quite consonant with the opinions which have often been expressed at the meetings of the Society: "Wide apertures (together with high powers) for those preparations only, which do not require perceptible depth of vision, i.e. for exceedingly flat or thin objects, and for transparent objects which can be studied by optical sections. Moderate and low apertures when a wide range of penetration cannot be dispensed with."

With great wisdom Professor Abbe explains the positive damage connected with the use of unnecessarily wide apertures and notices that increase of aperture may be prejudicial to the ease and convenience of microscopical work. It necessitates a progressive reduction of the working distance of the objective, and this is still further diminished during the necessary correction, for increase of aperture is inseparable from a rapid increase of sensibility of the objectives for slight deviations from the conditions of perfect correction. He impresses upon microscopists that the best wide-angled system, if not carefully adjusted when in use, is not better than a bad low-angled lens; for the tolerably sharp image which could be still obtained through the central part of the aperture only (even under the imperfect state of correction) is disturbed by the coarse dissipation of light from the ineffective marginal parts of the aperture. Dividing microscopists into those who amuse themselves and those who work, Professor Abbe advises the latter never to use wider apertures than are necessary for the effectiveness of the power, because excess of aperture always involves waste of time and labour.

It has always seemed an anomaly that when a good objective with a high numerical aperture has been obtained, many operators have diaphragms or stops added. The object of so doing is evident, but the practical difficulty arising from the small working distance is not removed. Moreover, there is a reasonable doubt whether an objective thus treated is really as effective as

one of a lower numerical aperture and of the same amplification. Professor Abbe writes, in reference to stops and diaphragms in relation to high numerical apertured lenses, "The greater penetration and insensibility of the low apertures may of course be attained thereby, but nevertheless this device is only a makeshift, and the result is inferior to that obtained by objectives originally arranged for a lower aperture. The low-angled lens which is made out of a good wide-angled one by means of a stop, is, in optical respects, a relatively bad objective—not nearly as well corrected as the same power would be if carefully adjusted for the lower angle." There can be no doubt that microscopists will require most carefully made objectives with a low numerical aperture as much as ever, and no wise man will confine himself to nothing else in the way of objectives than those of high numerical apertures, whatever may be the amplification. Clinching the argument, Professor Abbe concludes his essay with the remark, "Scientific work with the Microscope will always require not only high-power objectives of the widest attainable apertures, but also carefully finished lower powers of small and very moderate apertures."

One of the difficulties met with in the adjustment of objectives for correcting the aberration involved by the presence of a thin glass cover and a medium over the object, is caused by the awkward position and direction of movement of the screw-collar. A careful microscopist will of course keep the screw sufficiently easily moveable for his purpose, but unless this is done, the attempt to unscrew or screw up is often accompanied by drawing the objective out of the desired line of sight, and even by unscrewing it at the junction with the tube. In fact it is perfectly obvious to those who have the opportunity of working with other observers, that accidents readily happen to the object during the process of correction. These troubles have been noticed in every manual on microscopy. It appears, however, that the worm-wheel and tangent screw, suggested by Mr. J. Deby, when its application is made a little easier, will meet all difficulties, and it may be added to a screw-collar which could be used without the improvement in those rare instances when a rapid movement is required.

Very few microscopists care to correct their objectives during ordinary work, and principally because they have not seen the difference made in the appearance of an object by the process when it has been carefully carried out. But when an object, hitherto unsatisfactorily defined, presents itself under a clear and definite aspect, conversion to the opinion that there is an absolute necessity for correction in all delicate investigations regarding minute structures speedily ensues. There is no doubt that with very few exceptions the microscopic work relating to the morphology of the animal and vegetable kingdom has been conducted either without

corrected objectives or with those which have an average adjustment. I pointed out in my last address how abnormally thick, slender and excessively minute bodies appear under a high amplification; this is partly due to a want of correction, and mainly to another cause which it is not necessary to revert to. Now I have no hesitation in saying that similar abnormalities are constantly recorded as truths, and for that same reason which causes excellent observers to differ in a most remarkable manner about the appearances of the same object under different Microscopes.

Many microscopists do not know how to use the screw-collar, and I have taken the pains to inquire of several workers how they proceed to correct. A very general answer is, I focus the dirt on the top of the thin glass and then screw down until the object is in focus. So that this mistaken correction produces a double amount of error.

No one doubts the necessity for correcting dry and water-immersion objectives, or that it is very much less in the case of homogeneous-immersion systems, but in spite of Dr. Dippel's lively assertions to the contrary, practice has shown that an object whose true shape has been learned has been seen all the better after correction for the index of refraction of the thin glass cover with a medium above it and one below.

Doubtless this refraction is minimized by the homogeneous-immersion system, but even then there is the variable refractive index of the thin glass cover to be considered.

For perfect work, correction is necessary in the instance of the oil-immersion objectives.

Unfortunately the method of correcting, or rather the amount of approach of the front and back set of lenses of the objective which is required, has to be estimated empirically. Either the front lens and back pair are to be placed at a medium distance, and when the objective is focussed on the object this distance must be diminished or increased until what is believed to be the true shape of the object is seen; or what has the greater rudiments of exactitude in it, the focus having been taken with the lenses sufficiently distant for uncovered objects, the collar is worked to the left until the top of the thin glass is seen. Then the object is refocussed. This last plan would be the best were it not a fact that a source of error is revealed by the increase of amplification during the correction. The method of Mr. Wenham, by which the hinder pair of lenses is pushed forward towards the stationary distal lens, in correcting for cover, is vastly superior to the old plan of moving the front lens.

What exact relation there should be between the distance of the front and back series of lenses in the objective, and the thickness of the thin glass cover over the object, and that of the medium between

the object and the cover, must depend upon the refractive indices of the thin glass and medium, upon the aggregate of refraction due to their thickness, and the numerical aperture of the objective. Practically the relation is considered to be exact, and the distance between the objective series is made to equal the vertical distance between the top of the thin glass and the surface of the object during the process of correction. My impression, however, is that the distances are not equal in fact, and that that between the objective series is less than the vertical amount between the object and the top of the glass when a proper correction has been made.

It. has been put very forcibly by Dr. Dippel that if the shape of the object is unknown, correction may be a mistake, and that when the focus is at a lower plane than the summit of the object, correction may positively mislead.

There is no doubt that an image seen under a certain correction, and which is stated to be normal, is modified by under- and over-correction.

How to get at the truth is difficult, except in the instance of geometrical bodies and definitely parted lines, but the examination of the same object by many observers with different instruments gives experience, and without indulging in calculations, including the method of least squares, it is finally settled that such and such is the real shape.

The possibility of error remains, however, and it is perfectly evident that many a difference of delineation of carefully investigated objects results from non-correction and over- and under-correction. One cannot but help thinking that the difficulties in correcting dry objectives of high amplifying power and great numerical aperture, will lead to the almost constant employment of immersion objectives. And really the only researches which are rendered more difficult by the immersion principle, are those which have rendered the name of Dr. Dallinger so illustrious. There is no doubt that it is impossible to prevent the admixture of the medium with the water below the thin cover when minute organisms are followed here and there and often close up to the edge of the glass cover.

Amongst the results of not correcting objectives are want of definition, haziness, and the production of certain colours, and this last phenomenon is often observed in objectives which are corrected up to a certain degree and fixed. It is the fashion to correct and fix so as to obtain a certain amount of chromatic aberration, a ruby tint being considered the best. This is to obviate the effect which the perfect achromatism of a glass of large numerical aperture has on the eye.

Nevertheless this everlastingly recurring tint is objectionable and leads to misconception when dealing with extremely minute artificially coloured objects.

Dr. G. E. Blackham has made some very practical remarks on the correction adjustment for homogeneous-immersion objectives,* which have appeared in our Journal. He meets the reasons for dispensing with an adjustment, viz. no risk of decentering, the existence of a one best position in all objectives, the cost of the adjustment, and the trouble. He very properly remarks that the decentering need not take place if the optician does his duty to the brass as well as to the glass, and that cost is quite out of the question if the thing is possible and is required. And he observes that although the shifting of the positions of the systems of lenses is only an expedient, yet if it can be shown that it reaches the desired end more certainly, speedily, and accurately than any other, the objection to it must fall to the ground. Dr. Blackham qualifies the term homogeneous immersion, stating that it is true as to the idea but not in practice, for there are differences between the refractive powers of the front lens of any objective and the medium, and the refractive powers of different samples of crown glass are not the same. In alluding to the method of correction he appears to favour Mr. Wenham's mechanical process. He considers that the small adjustments can be made with more ease, rapidity, and accuracy by means of the screw-collar moving the back system of the objective than by means of the draw-tube.

Our Honorary Fellow Dr. Dippel considers all this, and whilst admitting that the theory of correction is true, believes that most of the arguments in favour of correcting combinations of lenses on the homogeneous immersion are fallacious or of no value and weight. He admits that with the correction-collar we are not so strictly limited to an immersion fluid of a particular index of refraction, and also that the correction-collar allows the same objective to be used with a longer or shorter tube, whilst its absence entails the employment of an objective within very narrow limits of tube length. He would have an average correction made and all screwed down hard and fast, believing that more errors will ensue after meddling with the normal correction than occurred before without any attempt at correction.

In concluding these references to the correction of objectives I cannot do better than quote Professor Abbe:—"Increase of aperture is inseparable from a rapid increase of sensibility of the objectives for slight deviations from the conditions of perfect correction. The state of correction of an objective depends on the thickness of the refracting film between the radiant and the front lens, represented by the cover-glass and that portion of the preparation which is above the actual focus. This is a variable element independent of the objective itself. In order to avoid large aberrations which must result from the change of that element,

* Proc. Amer. Soc. Micr., 1881, pp. 61-4.

its variation must either be confined to narrow limits or must be compensated for by a corresponding change in the objective. Now there is a great difference in regard to this requirement between the objectives of low and wide aperture, in particular with the dry system. An objective of a few degrees is almost insensible, it may be focussed at the bottom of a trough of water without any loss of performance. With 30° differences in the cover-glasses within the usual limits are still inappreciable, and an object may be seen at the depth of a drop hanging on the under surface of a cover-glass. With 60° a deviation of the cover-glass from its standard thickness by not more than 0·1 mm., or a corresponding increase of the depth of the preparation above the actual focus, will introduce perceptible aberrations and a visible loss of definition if not compensated for. With an aperture exceeding 100° in a dry lens the same result will arise from a change of thickness of 0·02 mm. only. To preserve the best correction in such a system would necessitate a change of the correction-collar for almost every change of focus in the inspection of successive layers, unless the preparation is exceedingly thin."

There can be no doubt that the majority of the recorded histology of the minuter structures will have to be worked over again with carefully corrected objectives.

Amongst the many excellent inventions for facilitating earnest, and of necessity, rapid microscopical work the apparently trivial arrangement perfected by Mr. E. M. Nelson, for changing objectives, must commend itself to every one. It facilitates the rapid interchange of objectives without the necessity of triple or quadruple nose-pieces and, in fact, will do away with the necessity of employing a nose-piece at all, a proceeding greatly to be commended, for those implements are often slip-shod abominations and bringers of error.

It is interesting to find that the invention utilizes a warlike appliance, and that breech-loading cannon, those latest developments of civilization in which, according to Herbert Spencer, the greatest admiration is obtained by those men who kill their enemies, have been studied and copied for the purposes of a pursuit which amongst others is making men more thoughtful and amenable to reason. Probably the Nelson adapter will replace the screw at some time or other, and it certainly cannot have some of the demerits of a coarse short thread, which is bound to interfere with the proper plane of the object-glass, and with the correct axial path of the rays into the body of the instrument.

In concluding these remarks on the Microscope itself I must enter a protest against the clumsy method of pushing a glass slide with a valuable and important object upon it with the fingers, under the objective and moving it about. Cheapness of the instrument and

want of scientific care are the temptations to and the causes of this very frequent source of error, which is intensified by the common fault of want of perfect flatness of the plane surface of the stand.

The beautiful adaptation of a sliding glass restricted by a point, whilst it relieves the microscopist from the expenditure involved by a complicated brass movement, is so easily fitted that there is no excuse for employing the fingers alone.

Some very remarkable communications have been made to the Society during the past twelve months, and one in particular marks an epoch in the science of microscopy. Whoever would have thought a few years ago of mounting objects in such media as bisulphide of carbon and phosphorus, and a solution of biniodide of mercury and iodide of potassium? Mr. Stephenson's paper places the results of these solutions before the world, and his introduction is explanatory of the philosophy of the relation of the refractive media in which the object is mounted, to the numerical aperture of the objective.

Almost as important as these new media, are the instruments which have been described in our Journal for slicing preparations. Some of these are marvels of ingenuity, and especially that one which employs the freezing apparatus as an adjunct.

Mr. Michael has continued his remarkable studies of the British Oribatidæ, and it is difficult to know which to admire most, the beautiful construction of the objects or the extreme care and ingenuity displayed in dissecting and mounting them.

The direction of microscopic research, however, has not been so much amongst the higher invertebrata, although great work has been done in them, as in relation to those legions of microscopic beings which are now shown to be a fertile source of misery to the human race. The most careful researches of old and the former study of the pathology of many fatal, so-called constitutional, diseases failed to bring their cause before the practitioner. Yet common sense and great experience had indicated to Holland, in the early part of this century, that germs or living entities were a *vera causa*. It required the present perfection of the Microscope and the development of the method of preparation and colouring to demonstrate bacteria in the tissues, to identify the bacteria of special diseases, and last, not least, to exhibit plainly and definitely the bacteria of phthisis pulmonalis.

Researches on the bacteria of septicæmia by Mr. Dowdeswell, on organisms in the excreta of animals and birds, and in ice, by Dr. Maddox, have appeared in the pages of the Journal, and they form but a small fraction of the immense literature of these lowly organized things. Certainly the Microscope has not done all in these investigations, for an elaborate chemistry has enabled skilled workers to stain and decolour, the bacteria remaining tinted.

A visible danger is better to face than the unknown: the one is possible of antagonism, the other is a terror. It may happen that now the Microscope has shown the minute bodies which accompany disease and which may produce it, it may lead to the discovery of the remedies. The competition in the research just alluded to is immense, and new methods are constantly being invented. They are great additions to science and may be the beginning of a new era in the great profession of medicine.

In concluding the former address which I had the honour of delivering to you at our last anniversary, I had the sorrowful duty of recording the death of one of the fathers of histological science, of a man who went to his rest full of honours and with the well merited reputation of a founder of a great theory. On this occasion I cannot help alluding to the loss this Society and science have sustained by the death of Professor F. M. Balfour, F.R.S., one of our Vice-Presidents. It is a saying as old as Grecian tragedy that those whom the gods love die young. Of rare promise, of gentle nurture, of singular modesty, this young but advanced student of nature will always be remembered with feelings of sincere sorrow and well merited admiration. He was a thorough scientist, and he laboured for truth's sake, caring little for that personal distinction which a happy combination of circumstances gave him at his early age.

VI.—*The Action of Tannin on the Cilia of Infusoria, with Remarks on the use of Solution of Sulphurous Oxide in Alcohol.* By Henry J. Waddington.

(*Read* 14*th March*, 1883.)

I am desirous of bringing to the notice of the Society this evening a matter which, though small in itself, may be of some use in the hands of experts. The immediate subject is the peculiar action of tannic acid on the cilia of *Paramæcium Aurelia;* but I may, perhaps, be allowed to digress a little at starting, in order that I may call attention to the methods I have used for keeping Infusoria for microscopical observation.

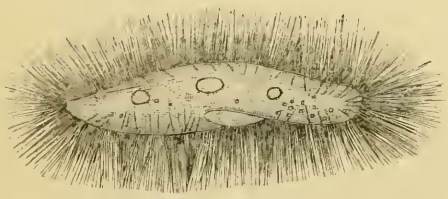
There are two methods which I have found very useful for this purpose. If small fragments of very hard burnt biscuit are dropped into water containing Infusoria, and held in suspension by pieces of weed or *Confervæ*, these crumbs, after a short time, form a nucleus from which fungoid growths spring freely, so that from a fragment of biscuit 1-32nd in. in diameter we may have a spherical growth of 3-4ths in. in diameter. These growths seem to be peculiarly fitted for the development of certain kinds of Infusoria, and they have this advantage—that when lifted out of the water, the filaments necessarily collapse, and act as a net to inclose whatever may be among them. When placed on a slip, a portion of these filaments may be spread out with needles, and they then serve the purpose of so retarding the motions of the Infusoria that their observation is comparatively easy, the extreme fineness of the filaments allowing the highest powers to be successfully used. It is necessary that the biscuit should be very hard and well baked, otherwise the fragments disintegrate. This method applies to Infusoria in aquaria, or in comparatively large quantities of water; but where they are contained in small troughs, I find that they thrive well on leaves of *Anacharis* or filaments of *Confervæ*, which have been reduced to a pulp with a little water in a mortar. If a few drops of this are occasionally added to the trough containing the Infusoria, they may be kept satisfactorily for a length of time. The small trough I have here to-night has been so kept for more than four months.

In trying the effect of various chemicals on Infusoria—principally *Paramæcium Aurelia*—I was led to use a solution of tannin, or tannic acid; and I was surprised to find that the immediate action of this chemical was to render the cilia visible without any manipulation of the light. It may have been noticed that when these Infusoria have been killed by ordinary means, such as heating the water in which they are contained, the cilia are very difficult

to observe, probably owing to their great transparency; so that no correct idea has, I think, been obtained of their size or quantity.

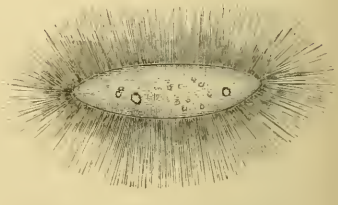
On placing, however, a drop of water containing *Paramæcia* on a slip side by side with a minute quantity of a solution of tannin, and making a junction of the two, it will be seen that the instant the *Paramæcia* approach the mixed fluids their motion is arrested, of course in a greater or less degree according to the strength of the tannin. They are generally rendered perfectly quiescent, and the cilia begin to appear and continue to develope, until the body of the animalcule appears entirely surrounded by them. The symmetry of the cilia depends much upon the strength of the solution; if it is too weak, it seems as if the animal had had time to slightly move the cilia, by struggling, as it were, as they appear crossed and crumpled; but if the solution of tannin happens to have mixed with the water in a better proportion, the cilia are more rapidly developed, and stand out almost parallel, hardly one being seen to overlap another. (See figs. 33 and 34.)*

Fig. 33.



Paramæcium after treatment with weak solution of tannin.

Fig. 34.



Paramæcium after treatment with a stronger solution.

To bring out the best appearance of the cilia over the whole of the surface of the *Paramæcium*, the parabola is required; the animal then appears as if it were supported on the slip by its cilia.

If the tannin solution is strong, the *Paramæcium* is almost instantly rendered motionless, and the cilia appear to be entirely removed, remaining in a more or less confused state at the extremity.

I have shown this action to several microscopists; and so contrary is the remarkable development of the cilia to received ideas, that on nearly every occasion I have been met with the remark that they were not cilia but fungoid growths. This is, however, entirely disproved by the fact that they are developed, as it were, instantaneously.

The action of the tannin on the cilia I believe to be analogous to its action on gelatine, rendering them leathery, and consequently

* In fig. 33 the cilia should appear rather more crossed and crumpled than they are there shown to be.

opaque. It does not appear to kill the *Paramæcium* itself—at least for some little time, unless the solution is very strong, as the rhythmical contraction and expansion of the contractile vesicles may be still observed. In the most successful observations it is probable that the tannin solution has been of sufficient strength to act upon the very delicate cilia, and, as it were, to paralyse them; while it has not been of sufficient strength to kill the animal outright. In the face of the accepted theory that ciliary motion is involuntary, it would be incorrect to say that the tannin acts upon the cilia in such a manner as to render them beyond the animal's control; but the cilia are certainly rendered inert, while the functions of the animal are but little impaired for a time.

The form of tannin which I have found most convenient to use is the glycerole of tannin, which is merely tannin dissolved in glycerine in the proportions of one part to four. It is a thick, viscid body, very stable, easily miscible with water, and consequently very manageable, as the quantity added to the water under examination can be well adjusted, and the action is more satisfactory than it would be if a solution of nearly the same specific gravity as water were used. Tannin in alcohol is not advisable on account principally of the repellent action between the alcohol and the water.

That the immediate action of the tannin in moderate quantity is not to kill the *Paramæcium* is, I think, apparent from the fact that Infusoria much more minute than *Paramæcia* seem to be little affected by it. I have constantly seen these become entangled in the cilia of *Paramæcium* that had been rendered motionless by tannin, and extricate themselves after a time apparently little affected by it. But such Infusoria have not possessed cilia of the same character as *Paramæcium*. On *Stylonychia* the tannin does not appear to have so decided an action, and whenever the cilia take the form of setæ the Infusoria seem much more capable of resisting its paralysing action, the peculiar jerky motion of the setæ being kept up for some time.

I have made the remark that I think no correct ideas have hitherto been held as to the size and quantity of the cilia; at any rate, I have never seen any drawing, or read any description of *Paramæcium*, as it is observed after the treatment by tannin. That the appearances observed are really cilia may be easily verified by the action of osmic acid, which kills the *Paramæcium* at once, and renders the cilia visible, but not to the extent that they are so rendered by the tannin.

I may also make allusion to the action of another chemical body on Infusoria, and to the advantages it seems to possess in microscopical research. This body is sulphurous acid, or, in the form in which I have found it most useful, solution of sulphurous oxide in

alcohol. The properties of sulphurous oxide are too well known to require any comment. I will merely mention that it is soluble to the extent of 30 volumes in 1 volume of cold water; but this solution soon changes into sulphuric acid by the action of air. If, however, the gas is passed into alcohol the quantity absorbed is greatly increased. If this saturated solution of the gas in alcohol is added to water, the gas, or the greater portion of it, is instantly thrown off. This alcoholic solution I have found most satisfactory in the observation of Infusoria. When a minute quantity is added to a drop of water on a slip, there is at first the repellent action between the alcohol and the water. This being overcome, the gas is given off, and its effect upon infusorial life is at once apparent. If the solution is strong, they are at once killed, and in most cases, if the Infusoria are ciliate, the cilia are rendered visible; but if the solution has been strong enough to be hurtful but not deadly, examination may be carried on very satisfactorily. The Infusoria are rendered almost motionless, while the ciliary action may be well observed.

If, under these conditions, the slip containing *Paramæcia* is allowed to become dry, the points of attachment of the cilia to the body of the animal are exceedingly well defined. Where the cilia have become detached, they almost resemble raphides.

I think that this reagent—sulphurous oxide in alcohol—is one that may prove of great use in microscopy. It is not so deadly as osmic acid, but it has a very marked action on Infusoria; while it is by no means so dangerous, and its cost is much less. The solution in water possesses very powerful bleaching properties, and the alcoholic solution, which is perfectly stable, furnishes a ready means of obtaining small quantities of sulphurous acid, for bleaching or other purposes.

I would merely add in conclusion that I consider I ought almost to apologize for dealing with a subject so very foreign to my usual microscopical pursuits. The experiments I have described have been carried out more as a microscopical recreation than as a scientific research; but they have appeared to me, and to those microscopists to whom I have shown them, to be of so much interest, and so capable in the hands of those more conversant with the subject than myself of further extension, that I have been induced to bring them forward.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

Development of the Ovum of Arvicola arvalis.†—The following are the chief points of C. Kupffer's investigation into the alleged reversal of the positions of the germ-layers in certain Rodents.

1. The ovum of the field-mouse forms a normal blastoderm, showing lamination in the region of the germinal disk, like the ovum of the rabbit.

2. The peculiarities of the field-mouse's ovum are caused by the covering-layer, which, instead of disappearing, as in the rabbit's ovum, proliferates and forms a plug which invaginates the active pole of the ovum. It is this invagination, thus brought about by an accessory growth, which causes the apparent reversal of the germ-layers.

3. With the exception of this invagination the course of development is normal. A complete yolk-sac is produced, and, judging by early stages, an amnion also, in the usual manner.

4. The mesoderm appears in the neighbourhood of a swelling, which is formed at a point in the periphery of the area embryonalis, and is to be regarded as a cæcal evagination of the ectoderm into the cavity of the yolk-sac. This swelling may with great probability be described as the commencement of the allantois.

5. Although differences have already been known to exist between the field-mouse's ovum, after assuming the cylindrical form, and the corresponding stage of the guinea-pig's ovum, it may nevertheless be stated as certain that Bischoff was right in interpreting the whole of the structure which he termed "plug" or "egg-cylinder," as an ovum.

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

† SB. Math.-phys. Kl. Akad. Wiss. München, xii. (1882) pp. 621–37 (1 pl.).

Reichert and Hansen held a different view, regarding as the ovum only a globular mass found in the free end of the cylinder.

Formation of the Embryonic Layers in the Trout.* — L. F. Henneguy in dealing with the vexed question of the origin of the primary blastodermic layers in Teleostean Fishes, comes to conclusions resembling those of Götte. The first trace of the embryo appears as a thickening at one point in the margin of the germinal disk; it is found from sections that the cellular layer which roofs in the segmentation-cavity, turns inwards towards the yolk at the margin of the disk, and penetrates this cavity; the corneous layer forms no part of this fold, but ends on the surface of the yolk. At the projection formed by the embryo, the blastoderm is thicker, and the inflected margin extends further into the cavity than elsewhere. At the pyriform stage of the embryo, when the posterior extremity forms a slight projection on the edge of the disk, the cells are found to present a concentric arrangement around the axis of the embryo, as described by Oellacher; the blastodermic layers are not distinct at this point, although in front of the caudal bud two are distinguishable in transverse sections made across the embryo, commencing at the caudal bud; the three primitive layers are found in the lateral parts of the embryo and at the caudal end; in the middle line only two, but below the axial cord (the commencement of the nervous system) is found the chorda dorsalis, formed from the lower part of the axial cord which originates from the primary endoderm at the same time as the mesoderm. In the anterior part of the embryo also, only the two layers are found. Longitudinal sections of this stage show the caudal bud to be formed of undifferentiated cells; in front of it, first two and then three layers are met with; the ectoderm increases in thickness from behind forwards, but suddenly becomes thin at the anterior extremity. The mesoderm, chorda dorsalis, and secondary endoderm only exist towards the middle of the embryo, and in front they become confounded with the primary endoderm. At that point in front of the caudal bud at which the three layers are developed, a peculiar vesicle appears in the secondary endoderm. The nervous axis is developed at the cost of the ectoderm and the corneous layer takes no part in its formation; from the first, it is clearly separated from the chorda dorsalis; when the medullary cleft is about to be formed, the central cells exhibit karyokinetic figures and divide; the daughter-cells separate, leaving between them a space, the future central canal. These cells are very delicate, whence has arisen the erroneous idea that they normally undergo destruction.

Distinctions between Organisms and Minerals.†—Dr. H. Valin has repeated the interesting experiments of MM. Monnier and Vogt on the artificial production of organic forms.‡

In a flask full of soluble glass were placed fragments of sulphate of iron, ten grains in weight, which immediately began to assume a

* Comptes Rendus, xcv. (1882) pp. 1297–9.
† Amer. Natural., xvii. (1883) pp. 233–4.
‡ See this Journal, ii. (1882) p. 320.

colloid condition on the outside, and shot out tubular prolongations, colloidial and cellular, which grew at the rate of half an inch in twenty-four hours. Some attained to 2 in. in length, and were about 1-12th in. in diameter. All these prolongations shot out a number of slender filaments from various points of their surface, and these attained a length of a few inches in a few hours. After a few days or weeks all these assume a crystalline condition and become empty inside. Some of them rise to the surface of the liquid. They are insoluble in water, remain intact when exposed to air, and when introduced in a newly-prepared flask at the same time with fresh fragments, they hasten the metamorphosis of the latter. The addition of water to the soluble glass renders the experiments more easy and saves time.

Watched under the Microscope, the fragments of sulphate of iron are seen to swell all around. An unctuous colloid mass is formed, which consists of fine granules perfectly similar to animal tissues. This mass stretches into prolongations, and fluid contents are seen to flow inside them. When the surface of some prolongations was opened, a semi-solid substance grew out of the opening into new prolongations. One of these mineral organisms, when placed on a fresh fragment, shot out new prolongations, as if real grafting had taken place.

"Organisms" of sulphate of copper, sulphate of zinc, alum, phosphate of iron, &c., were similarly obtained, each possessing a form peculiar to itself and distinct from the others. Analogous forms grew in saccharated lime-water. Cellular bodies of the same mineral formed in solutions of alkaline carbonates.

The following we transcribe verbatim from the report of the meeting at which the paper was read :—

"These experiments relate to the almost unknown department of chemistry which treats of colloids, and as crystalline solutions grow into symmetrical crystals, so a colloid substance in process of formation assumes a typical form, and must be the start of all forms in animals and plants. These so-called mineral organisms, viewed with the naked eye and the Microscope, or chemically tested, come as near to the lower animals and plants as these are from one another, and form a new field of investigation for the biologist. We can no longer say that only living things grow, unless we reckon these as living.

"Among the conclusions of Dr. Valin's paper were these: 'That the vitality of growth of these mineral organisms consists in the passage of a crystal into a colloid, and is thus correlated, but not identical, with the kinetic process known as crystallization. That the molecule of the bodies consists of many elements, and that acid and alkaline polarities are always concerned in their growth, for only acid minerals in alkaline solutions gave rise to them. That we have a right to suppose that living protoplasm is nothing but a highly complex mineral organism in favourable media (water and air).'

"This would tend to confirm the growing belief among biologists, that life is nothing but the energy manifested by the forty and odd (Reinke) proximate principles which constitute protoplasm, when they pass from the crystalline or soluble into the colloid state in the proper media."

B. INVERTEBRATA.

Mollusca.

Development of Reproductive Organs of Pulmonate Mollusca.* —H. Rouzaud finds that the reproductive organs of the Pulmonata arise from an ectodermic bud, which is primitively simple and claviform, and which he calls the primitive bud. The hermaphrodite gland is merely the free ramified apex of this bud. The bud itself is formed by the cutaneous envelope in the region which separates the head from the pallial "collar," and always arises at the spot at which the common or the female orifice is afterwards developed. At first claviform, it becomes cylindrical, and, following the general integument, soon extends to the level of the liver. Its basal region soon gives rise to a secondary bud, the rudiment of the penis, of the male efferent canal, and of the flagellum. At its free end this bud soon presents a tract of muscular tissue which is connected with the wall of the body, and is the representative of the future retractor muscle of the penis. Inferiorly to this, there is developed another bud—the sagittal—which is the rudiment of the dart-sac. In a large number of so-called *Helices* the base of the sagittal bud also proliferates and gives rise to a certain number of tertiary buds which form the glands or multifid vesicles; these should, however, be regarded as parts of the dart-sac. The median region now presents two clefts, which are distinguished as the utero-copulative, and the utero-deferent. With the former there becomes connected the copulatory pouch, and with the latter the oviduct. The arrangement of the parts are such that the dart and the "copulatory cellular layer" are the symmetrical homologues of the penis and the efferent canal.

There are, then, three tracts of cells; the median one, which is the oviduct, gives rise to the albuminiparous gland. While these changes have been going on, the tip of the primitive bud has been actively proliferating, and has given rise to a number of rudimentary lobules of the hermaphrodite gland. The sexual products would appear to be derived from the ectoderm.

Developmental History of the Prosobranchiata.† — Dr. Carl Rabl's memoir is divided into two parts—the first treating of the question of the ultimate fate of the gastrula-mouth in *Paludina vivipara*, while the second relates to some later developmental processes in *Bythinia tentaculata*.

The question of the fate of the gastrula-mouth is of great theoretical importance; and there is at present scarcely a point in developmental history about which there has been more dispute, and upon which opinions are more divided. The author finds that in *Paludina vivipara* the gastrula-mouth gradually but completely closes in the median line of the ventral surface; that, further, soon after its closure the anus makes its appearance, but is in no way connected with the gastrula-mouth; and that, lastly, the permanent mouth

* Comptes Rendus, xcvi. (1883) pp. 273–6.
† Anzeig. Akad. Wiss. Wien, Jan. 18, 1883, p. 13.

appears at the spot where the last residue of the gastrula-mouth had closed up. These statements are certainly in contradiction to those of some other authors, but show that a common mode of development may be set up, at least for the Gasteropoda.

The second part treats of the structure of the velum, the origin of the upper œsophageal ganglion, the structure of the primitive kidneys and the intestine, and of the development of the persistent kidneys. The author finds that the velum in *Bythinia* is composed of large cells containing vacuoles, and differs in some other characters from the corresponding organ of other Gasteropod embryos; that the superior œsophageal ganglion originates in the form of a thickening of the outer germ-lamella (vertical plate); that the primitive kidneys are composed of a few, not very large, perforated cells; that the foundation of the persistent kidneys stands in no genetic relation to the ectoderm; and, finally, that in some respects the intestine possesses interesting peculiarities. The author has endeavoured to bring these results into agreement with his previous statements upon the development of *Planorbis*, and to show that the same laws which had proved to prevail in the case of *Planorbis* apply also to *Bythinia*, and that the differences result from the greater abundance of nutritive vitellus which is presented by the germs of the latter.

Norwegian Buccinidæ.*—H. Friele describes the Buccinidæ of the Norwegian Arctic Expedition, which may be said to be especially at home in the arctic and northern seas of both hemispheres. According to the views of the author, this family comprises the genera *Jumala* with one species, *Volutopsis* with one species, *Pyrolofusus* with one species, *Neptunea* (*recte Neptunia seu potius Neptunina*) with seventeen species, *Troschelia* with one species, and *Buccinum* with twelve species; in all six genera and thirty-three species. The varieties of other species are also noticed. Ten species are for the first time described and figured. It may be doubted whether the grounds of distinction between these genera are sufficient, and whether they are not all merely sections of the Lamarckian genus *Fusus* and the restricted genus *Buccinum*. The author attaches considerable importance to the dentition as a generic character; but this is, at any rate, a difficult basis of classification. What are we to do with the fossil, and consequently now toothless, Gastropods? The structure, and even the presence of the odontophore, in that order of Mollusca depends on the nature of their food. Herr Friele has conclusively proved that in the Buccinidæ "diversity of dentition affords anything but a trustworthy guide" in distinguishing species. One important character of such distinction has not been lost sight of by him, viz. the shape of the apex or embryonic whorls.

Sinisigera.†—A. E. Craven, who has published a monograph on this genus, now states that he has been satisfied as to the shells of

* 'Den Norske nord-havs-expedition, 1876–8. VIII. Zoologi, Mollusca· 1. Buccinidæ.' 6 pls. and map. 4to, Christiania, 1882. Cf. Ann. and Mag. Nat· Hist., xi. (1883) pp. 216–9.

† Ann. and Mag. Nat. Hist., xi. (1883) pp. 141–2.

this group belonging to the larvæ of various Gasteropods. He figures a specimen from the collection of the Rev. R. B. Watson, in which the "pullus" and the shell of the adult are both seen. The members of the genus *Sinisigera*, as hitherto regarded, appear to be the pulli of many and varied genera. It is possible that, driven far from shore by currents or storms, they pass their existence as larval forms and never attain maturity. If this is the correct explanation, we can understand how it is that, though so numerous, they are so constant in size, and how it is they are dredged in a dead state from great depths.

Green Colour of Oysters.*—Additional investigations have served to convince Mr. J. A. Ryder that the coloration is unquestionably due to a staining of the blood-cells of the animal, and that the colouring matter is either derived from without or else may be a hepatic colouring principle, which through some derangement of the normal metabolic processes of the animal, has been dissolved in the lympho-hæmal fluids, and so been taken up by the blood-cells or hæmatoblasts and given them their peculiar colour. The hypothesis of tinction in no way disposes the author to assign a less value to the influence of the food, as the primary initiatory agency in effecting a staining of the internal ends of the cells which form the walls of the hepatic follicles. In fact, in certain oysters most affected, the hepatic follicles are most deeply stained internally. He has failed to prove by spectroscopic research that this substance is chlorophyll, and his belief that it is chlorophyll at all, has been weakened by the fact that specimens which had the liver dyed deep-green and were affected in other parts, have shown no disposition to part with their colouring matter, although immersed in strong alcohol for months, during which time it has been changed two or three times. Chlorophyll would not be likely thus to retain its colour.

The hypothesis of vegetable parasites has in the author's opinion no foundation whatever.

Sucker on the Fin of the Heteropods not a Sexual Characteristic.†—The posterior margin of the "fin" of the three genera of Heteropoda, *Pterotrachæa*, *Firoloides*, and *Carinaria*, bears a small sucker-like body which many authors allege to be characteristic of the male of the two former.

This structure, Mr. J. W. Fewkes says, is sometimes found on the fin of the female. Among a number of specimens of *Pterotrachæa coronata* collected at Villa Franca, he found a perfect female with this organ as well developed as in the males. He has also studied specimens of *Firoloides lesueurii* in which ovaries were well developed where the sucker was present. Most observers agree in saying that *Carinaria* has the primal sucker in both sexes.

This organ is probably not confined to either sex in the above-mentioned genera. Morphologically it may be regarded as a functionless organ, or the remnant of a structure which in those

* Amer. Natural., xvii. (1883) pp. 86 8.
† Ibid., pp. 206–7.

Gasteropoda from which the Heteropods sprang was of great importance. The free-swimming habits which these active molluscs have, caused its reduction to a rudimentary organ.

Growth of the Molluscan Shell.*—Mr. H. L. Osborn points out that the structure of the molluscan shell has been studied by means of sections of adult shells by Carpenter and others, who have found that it presents an outer, membranous, horny epidermis, and an internal stony portion. Such a method could not give any idea of the actual process of shell-formation, and a knowledge of this could be gained only by study of the first steps. To this end, edges of the shell were snipped away and a thin glass circle thrust between the animal and its shell, care being taken to prevent injury to the mantle. After the lapse of twenty-four hours the shell was opened and the glass circle carefully examined, others were allowed to remain two days, or three days, or for periods of weeks.

In twenty-four hours it was found that a film had been left upon the circle; in forty-eight hours, this film was plainly stony. The earliest traces of this film when treated with colouring reagents, stain, but, when treated with acids, show no traces of lime, nor any evidences of structure; it is simply a structureless membrane. Later films, when treated with acetic acid, present the appearance of a tesselated pavement, and when examined with the polariscope and not treated with acetic acid, show beautifully the presence of lime.

It would thus appear that the epithelium of the mantle pours out a secretion of horny matter which forms the epidermis; that this secretion holds lime in solution; and that from this the stony internal portion of the shell is formed. Experiments were successfully made upon the shells of the oyster and *Pinna* and several other Lamellibranchs, and some Gasteropods were tried, but thus far in vain.

Molluscoida.

Individual Variation in Ascidians.†—Prof. Herdman points out that the specific determination of Ascidians has always presented considerable difficulties, owing to the apparent absence of reliable characteristics. His own investigations have shown him that the "olfactory" or dorsal tubercle is very variable, and the same is largely true of the branchial sac. Further observations on the common *Styela grossularia* have led the author to recognize a "continuous series connecting a well-developed branchial fold with the most rudimentary indication of where the fold ought to be." We may have, that is, the projection of the sac disappearing, while the bars are still close; the bars may then become more open; then there may be only three rows of narrow meshes; then two, then one row; this single row may extend only part of the way, and at last, the right-hand fold may be entirely absent. All the branchial sacs described were found in individuals with fully developed genital organs. In addition to some illustrative figures, an ingenious diagram illustrating this variability is given.

* Johns Hopkins University Circulars, 1882, Nov., p. 7.
† Proc. Lit. and Phil. Soc. Liverpool, 1882, pp. 12 (2 pls.).

Gemmation in Didemnidæ and Botryllidæ.*—A. Della Valle finds that the body of each animal, when adult, consists as in the true Enterocœlia, of two epithelial sacs, ectodermal and endodermal, which are separated by a cavity occupied by a true enterocœle, a sac derived from the intestine; this cavity communicates with the exterior directly by the cloacal orifice, and indirectly by the branchial clefts.

All the organs which are not directly derived from the true endoderm (sexual organs, heart, and muscular fibres) arise between the ectoderm and the parietal wall of the cœlomic sac.

As to the question raised by Prof. Huxley as to whether the Ascidians are true Enterocœlia, we have to note that the question is based on the belief of Kowalewsky and other observers that the atrial orifices and the atrial sacs themselves are formed from the ectoderm. The author, however, finds that after the formation of the branchio-intestinal sac two extroflexions arise in its lower part; these grow rapidly and soon cover part of the median sac; this last is prolonged downwards to form the intestine, which becomes folded against one of the extroflexions, while the lateral sacs approach the ectoderm. Where they do so the ectoderm forms an introflexion, and, the opposed cæca meeting and uniting, we have the endoderm communicating with the exterior by two orifices; these, later on, unite and form the permanent cloacal orifice. Dealing with the statement of E. van Beneden that the enterocœle of the larva disappears completely, the author points out that this view is not only contradicted by the evidence afforded by a transverse section but also by an inspection of a living *Perophora*, where the blood-corpuscles in the branchial sac may be seen moving between two membranes. Contrary to the views of "Jolin" (? Julin) the author agrees with a number of other observers in regarding the body-cavity of *Amphioxus* as exactly comparable to the peribranchial cavity of Ascidians.

In the Didemnidæ gemmation is a cause of rejuvenescence, or of the formation of new individuals; either of them are always due to the connection of two buds, which may be "brothers," or "mother" and "daughter," or "grandmother" and "granddaughter." During their period of adhesion the buds are the cause of polymorphism. In the Botryllidæ one bud is sufficient for the production of a new individual, and this is formed by an extroflexion of the parietal wall of the peritoneum of the parent which gives rise to a similar extroflexion of the ectoderm; as a rule there is but a single bud on either side; as soon as the peritoneal sacs are developed, the new buds are ordinarily provided with generative organs; in some cases, however, a whole colony may be seen to be without ova.

Anatomy and Histology of Ciona intestinalis.†—In this hermaphrodite Ascidian L. Roule states the testis and ovary to be distinct from each other; their activity lasts throughout the year. The testis consists of an aggregation of tubes inclosed by the connective tissue of the wall of the intestine, i. e. of the curvature

* Arch. Ital. Biol., ii. (1882) pp. 50–72 (3 pls.).
† Comptes Rendus, xciv. (1882) pp. 1652–5, 1726–9.

between the stomach and rectum; they form quite a ridge on one side by their close aggregation at this point; they are surrounded by a dense plexus of capillaries, and add considerably to the thickness of the walls of the intestine; most of the secretory tubules of the testis converge towards the base of the stomach, where they unite in the vas deferens which then crosses the body-cavity, accompanied by the gastro-ovarian vessels, and unites with the oviduct at the anterior end of the ovary. The ovary is a large oval body lying in the body-cavity between the heart and the intestine, with a pointed anterior extremity whence the oviduct, which is wide and has thin transparent walls, proceeds; the gland is covered externally by the endothelium of the body-cavity and is divided internally into large partitions by irregular trabeculæ of connective tissue; the spaces contain ova in all stages of development. The joint oviduct, vas deferens, and upper branchial vessel meet the intestine near the end of its curvature and accompany it to its termination, being attached along the line occupied by the spermatic ridge on the interior. This ridge ceases to contain spermatic glandules at the rectum. The joint cord executes a twist half round the intestine; being above it at the end of the curvature and below it at the anus. The walls of the oviduct and vas deferens consist of a thin lamina of connective tissue, covered externally by a pavement epithelium consisting of one layer of small cells; the internal epithelium is ciliated in the oviduct, in some parts of the male duct it has the character of an endothelium, the cells being broad and flat. The two generative ducts open together in the cloacal cavity in a small beak-like prominence which is terminated by a red organ. The orifice of the oviduct is surrounded by muscle-fibres, that of the vas deferens by about 10 to 15 small diverticula, inclosed in a sheath of connective tissue; the cavities of these diverticula are lined by large flat epithelium-cells, behind which come two or three layers of orange-coloured strongly granular cells, resting on the connective tissue, which is perforated by numerous blood-capillaries. The orange cells contain uric acid, oxalates (probably oxalate of lime) and phosphates, and their function must be renal. The spermatozoa arise from slightly granular cells in which no nucleus was found and which are the outer members of certain aggregations of cells into masses called *polyplasts;* in the outer cells of which appear hyaline spaces which are detached as distinct non-nucleated cells, and accumulate outside their parent cells; they are the *deuto-spermoblasts*, and each produces a spermatozoon, whose head is attached to the parent cell until it is liberated.

The circulatory system of this and other Ascidians is distinguished by the abundance of anastomotic branches of almost the same calibre as the vessels which they connect. The circulatory currents are thus indefinite in direction, and the distinction between venous and arterial blood is not long maintained. Three main currents may, however, be distinguished, viz. cardio-splanchnic, splanchno-branchial, and branchio-cardiac; the mantle receives small vessels from all the organs which are in contact with it. The heart is bent on itself, and gives off two vessels of equal length; it, together with these, is contained in a roomy Y-shaped pericardium. The mantle contains a

close network of vessels communicating with those of all the viscera, the most important being those which pass between it and the branchiæ. There are no vessels proper to the test.

The elements of the blood are (1) cells with ramifying processes, analogous to the lymph corpuscles of Vertebrata; (2) round or mammillated refractive bodies of a deep brown colour, the result of degeneration of the preceding. Both these kinds are also found in the connective tissue everywhere, whither they seem to have migrated from the blood; (3) yellow granular cells, very scarce; they resemble the cells composing a special organ which is attached to the vas deferens.

The branchia is a network of thin-walled vessels; its fundamental elements are transverse vessels, which connect the afferent and efferent vessels; they are themselves connected by small longitudinal tubes; there are also two further series of transverse and one of longitudinal vessels. The blood-vessels in general are excavated in the substance of the connective tissue, where they form regular lacunæ, whose cavity is partially filled with connective tissue and lined with epithelium. The heart is the only part of the vascular system which has a complete muscular lining, although the superior and some of the transverse branchial vessels possess isolated smooth muscular fibres. The branchial vessels are distinguished by an unusually thin connective tissue layer, covered externally by a pavement epithelium which is ciliated in parts.

In a subsequent paper * the histology of the species is described in detail, for which the original text must be consulted.

Mediterranean and Atlantic Bryozoa.†—M. Alphonse Milne-Edwards gives a preliminary report of dredgings at great depths in the Mediterranean and Atlantic Oceans from which it seems that the full report will, among other things, add very largely to our knowledge of the Mediterranean Bryozoa. A list is given of 71 species. The author says that *Setosella vulnerata* only seems to reproduce itself at great depths, as he found ovicells on specimens from 1068 metres while from less depths they are unknown. From having material from more favourable ground he is able to give the form of the ovicells of two species of *Frondipora* and *Reticulipora*. As the ovicells of so large a number of Cyclostomata are unknown this is very important, both of these genera belonging to a form of growth which is very sparely represented in the recent fauna, though abundant in some geological formations.

Arthropoda.

a. Insecta.

Colour and Pattern of Insects.‡—Dr. H. A. Hagen considers that colour and pattern are produced by physiological processes in the

* Comptes Rendus, xcv. (1882) pp. 45–7.

† "Rapport sur les Travaux de la Commission chargée par M. le Min. de l'Inst. Publ. d'étudier la Faune sous-marine dans les grandes profondeurs de la Médit. et de l'Ocean Atlant., par M. Alphonse Milne-Edwards." Extr. des Arch. des Missions Scientifique et Lit., ix. (1882).

‡ Proc. Amer. Acad. Arts and Sci., xvii. (1882) pp. 234–67.

interior of the body of the insect, and not in a purely mechanical manner, as contended for by Prof. Weismann.

Colour is influenced not only by air and light, but also by heat and cold and the wetness or dryness of the atmosphere, the season, and the character of the country. Dr. Hagen distinguishes colours as optical and natural. The former are produced by interference in two different ways: either by thin superposed lamellæ, or by many very fine lines or small impressions in very near juxtaposition. There must be present at least two superposed lamellæ to produce colours by interference. There cannot be more than four layers in the wings and scales, which show principally such colours in insects—two external ones belonging to the cuticula, and two internal ones belonging to the hypodermis. The naked wings of Diptera and Neuroptera often show beautiful interference colours. The scales of *Entimus* and other Curculionidæ are well known for their brilliancy, and it is interesting to remark that when dry scales are examined with the Microscope, many are found partly injured, which give in different places different colours, according to the number of layers which remain, the elytra of some Chrysomelina and other beetles with iridescent colours probably belonging to the same category.

Secondly, interference colours are produced by many very fine lines or striæ in very near juxtaposition.

Perhaps in the colour-changing butterflies natural colours are combined with optical colours, or perhaps interference colours produced by superposed lamellæ are combined with those produced by fine striæ. It will be necessary to deprive the wings of their natural colours by bleaching, and then to make the microscopical examination. Dr. Hagen has begun experiments for this purpose. The wings of *Apatura clytie*, a variety of *A. ilia*, are pale yellow in the colour-changing part; the wings of *Euplœa superba* are velvety black above, the black changing into violet in the colour-changing part. Both wings put in eau de javelle began to grow pale after an hour. The paleness began first in the colour-changing part of *E. superba*, and was less visible in the much lighter coloured wings of *A. clytie*. After one hour and a half the whole colour-changing part of both species was entirely hyaline. The not-colour-changing parts were very little affected, and in *A. clytie* the light-brown spots were nearly intact. Both wings had lost entirely the change of colours. The microscopical examinations showed that the scales of the colour-changing parts were very much affected. The scales were hyaline, nearly visible; the longitudinal striæ less sharp, the transversal ones even more affected, and mostly obliterated. In some places, in the middle of the colour-changing part, the scales had disappeared, and only their stems were left. On the other hand, the scales of the not-colour-changing parts were nearly unchanged, and both kinds of the striæ as sharp as before. The under side of the wings does not change colour at all, nevertheless, the parts corresponding to those iridescent ones of the upper side were affected as much and in the same manner as the scales of the upper side. From the beginning of the bleaching process both sides made the same progress in becoming hyaline.

Now the striæ of the scales, though they had been much affected

by the bleaching, could not be the producers, at least not alone, of iridescence, as in all not-colour-changing scales the striæ are exactly of the same arrangement and distance, just as fine and approximate as in the iridescent ones. Therefore it may be presumed that the lamellæ of the iridescent scales are more distant one from the other, less firmly glued together, and therefore easier affected by the bleaching fluid, and the coloured substance between the lamellæ easier bleached. But why are the corresponding not-iridescent scales of the under side of the wing also affected, and at the same time with those of the upper side? It can only be supposed that the quick effect upon the scales on one side of the wing gives easier access to the scales on the other side. The author confesses that he is not entirely satisfied with this explanation, but he does not know of a more satisfactory one. For the first experiment the wings were cut through the middle of the colour-changing part, and were therefore perhaps more quickly affected. In subsequent experiments with entire wings of *Euplœa superba* the iridescence was gone in three-quarters of an hour, but the wing was only less dark even in the colour-changing part. In the same space of time wings of *Apatura iris* and *ilia*, and of *Thecla quercus* were entirely bleached, those of *Lycœna Damon* only partly. The question whether the striæ of scales with more distant lamellæ will help to produce iridescence which the same kind of striæ of scales with not-distant lamellæ does not do, he is unable to answer.

The colours of butterflies change mostly from purple to blue, sometimes to yellow. Probably a calculation based upon the appearance of these colours might help to solve the question.

Interference colours are also produced by very small impressions in juxtaposition. Such an arrangement is found on the feathers of birds; for instance, on the neck of pigeons and elsewhere. In the hairs of *Aphrodite* and *Eunice* this arrangement may be compared with striæ. Perhaps this kind of interference colours is found more frequently among insects than is commonly known. At least there are often parts of insects, and their limbs in appearance yellowish, but in a certain direction changing to brown or blackish. Dr. Hagen knows of no other explanation of this not uncommon fact on the legs of Diptera, of Hymenoptera, and of Phryganidæ.

Natural colours are of two different kinds. (1) the pigment is deposited in the form of very small nuclei in the cells, or in the product of cells, in the cuticula; (2) the pigment is a homogeneous fatty substance, a kind of dye somewhat condensed.

The first kind belongs to the cuticula, and may be called *dermal* colours. Dr. Hagen considers them to be produced mostly by oxidation or carbonization, in consequence of a chemical process originating and accompanying the development and the transformation of insects. To a certain extent the dermal colours may have been derived from hypodermal colours, as the cuticula is secreted by the hypodermis, and the colours may have been changed by oxidation and air-tight seclusion. The cuticula is in certain cases entirely colourless. The dermal colours are persistent, never becoming obliterated or changed after death.

The second kind of colours belongs to the hypodermis—*hypodermal* colours—and are the consequence of a chemical process, generating colour out of substances contained in the body of the insect. These colours may be changed into other colours by light and heat, perhaps by acids or by the influences of the sexual organs. If such a change were to a certain extent a photographic process, some important facts (mimicry) could be understood, which otherwise are inexplicable. The hypodermal colours are generally brighter and lighter than the dermal, and mostly fade, change, and disappear after death, an exception existing, however, in the case of certain colours of the elytra and wings, of the hairs, scales, and appendages of the body. The hypodermal colours are very often different in males and females of the same species, but the dermal more rarely differ. The former change during life-time by sexual influences, cold, &c.

There occur in a number of insects external colours, that is, colours upon the cuticula, which are displaced hypodermal colours: produced in the hypodermis and exuded through the pore canals —the nearly pale blue or white upon the abdomen of some Odonata, the white on many Hemiptera, the pale grey on the elytra and on the thorax of the Goliath beetle, and the yellowish powder on *Lixus*.

The question of the pattern is then considered, the author believing that a more detailed study of the different patterns which are to be found in different groups, and perhaps the development of the law according to which the pattern is changed in different groups, would advance us nearer to the knowledge of its nature and origin.

The pattern is not the product of an *accidental circumstance*, but apparently the consequence of certain events or actions in the interior of the insect mostly at the time of its development. The proof is easily afforded by the regularity of the pattern in the same genus or the same family. If studied carefully and comparatively, the pattern for such a genus is the same for all species, but for some of them more or less elaborated.

Weismann, in his study of the origin of the pattern of caterpillars of the Sphingidæ, contends that all the patterns and colours possess only a biological value. The green colour, which first appears, corresponds to that of the leaves. But in a large caterpillar one main colour would be too apparent; therefore longitudinal lines separate the main colour into several fields and diminish the danger, the more so when the caterpillar lives among grasses. The oblique lines form a similar protection, and are even more effectual when the lines have coloured borders, which make them resemble the ribs of leaves. The eye-spots of *Chœrocampa* are said to frighten enemies, and the variegated colours of *Deilephila* to designate them as not eatable. The dark colour of full-grown caterpillars of *Chœrocampa* is said to be owing to the impossibility of being protected by any colour, on account of its large size. These caterpillars acquire, therefore, the habit of feeding at night, and hide themselves during daytime under dead leaves. As, therefore, every one of the characters is of biological value, they can be explained by means of natural

selection, and the necessity to admit a phyletic or inborn power does not exist. The possibility of the existence of such a power is rejected by Weismann.

The conclusions of Weismann are based upon a number of European species. But it seems that the study of exotic species will show that some of these conclusions cannot stand, or will lose at least a large part of their value. The colourlessness of the newly-hatched caterpillars is perhaps not without exception in some tropical species. The succeeding green colour belongs to the hypodermal colours, but all the longitudinal and oblique lines and the spots belong to the dermal colours. The dorsal lines are the consequence of the situation of the dorsal vessel; probably the subdorsal line and the oblique lines are muscular lines, and the stigma line a consequence of the large longitudinal tracheæ. The large eye-spots on the thoracic segments indicate the place under which the wings are beginning to be formed. Similar spots, but less strongly developed, are to be found in a number of larvæ of Myrmelionidæ. The formation of the wings necessitates a largely accelerated circulation in those places, and therefore an oxidation of the cuticula. These eye-spots belong to the dermal colours.

In some few instances the author has been able to observe how the pattern is produced. In dragon-flies (Odonata) the thorax is transparent and entirely colourless at the moment of transformation. At this time the muscles are in process of formation. The thoracic muscles of the Odonata are, as is well known, very powerful, and rather exceptional in the shape of their tendons. Very strong currents of the blood were observed just along the place where the muscles were developing. The rush of the blood was very much accelerated. Now just outside of these we find in Odonata dark lines or bands, which appear to be the result of the formation of the muscles. *Ubi irritatio, ibi affluxus;* therefore it is not improper to conclude that a powerful action in the development of the muscles is here the cause of a stronger combustion and of an oxidation in the adjacent parts of the external crust of insects. But not the pattern of the thorax alone follows the lines of the muscles. On the head we find a certain pattern corresponding to the muscles of the mandibular apparatus; another one on the segments of the abdomen corresponding to the so-called respiratory or abdominal muscles, and another one on the legs corresponding with their muscles. It is important to remember that those patterns are better and more definitely developed in the most powerful flying Odonata, as in the Æschnina, and especially in the Gomphina. The main colour of the Gomphina is yellow of different shades, mostly greenish-yellow; and the stronger the species the larger is mostly the pattern of blackish bands.

The same proceedings were observed in *Cicada* just emerging from the nympha skin. On the head, thorax, abdomen, and legs appear similar patterns, corresponding to the muscles or to their insertion places. In fact, where a stronger circulation exists in insects, the part becomes more strongly chitinized and darker coloured.

Should this explanation of the facts be accepted we shall have

taken a step forward in understanding the origin of the pattern. The author knows very well that among the Odonata patterns exist which do not agree with the explanation, and in one case are even opposed to it. But though most of the patterns can be explained in this manner, there may exist other factors still unknown explaining the opposite patterns. The explanation given can be considered as admissible as long as the number opposite to it is a comparatively small one. The pattern on the wings and elytra cannot, of course, be the product of action near or along the muscles, as these limbs are unprovided with them internally. But it seems probable that there the sudden rush of blood and air by the accelerated circulation and respiration during the act of transformation produces the same effect. At least some patterns, the origin of which would be inexplicable, would be understood by it.

If a stream or jet of blood passing through the narrow base of the wingbag should meet within its centre a small obstacle, the previously straight stream would take the form of a funnel. Should this obstacle be a kind of ring, the funnel shape would be retained by the stream, but its central portion would pass undivided through the ring, and upon meeting another obstacle would produce a second funnel. Therefore there may be two or more funnels, one within the other, and a section of them will be circular or elliptical according to the angle to which they reach the inner surface of the wing. A curious fact seems, the author thinks, to support his suggestion. Nearly every larger ring or eye-spot of the wings shows a white interruption or spot in some place. Now as it is impossible that any obstacle, such as mentioned before, can be entirely free and isolated in the stream, we must presume that it is somewhere connected with the interior of the body, and is perhaps produced by some prominent ridge or corner, and then the funnel or the ring must be interrupted in some place by this connection. If it is so, this place will not be oxidated (colourless) and will correspond to the white spot mentioned before.

There is still another circumstance which explains some patterns. The walls of the bag which will be later a wing or elytron are very strongly enlarged and suddenly dilated during the act of transformation. Therefore small rudimentary patterns in the bag will be altered and enlarged by the same proceedings. Many patterns of Lepidopterous wings can be easily explained in this way. All the wavy lines and similar marks belong to these patterns. As the ribs or veins of the wings seem to grow faster in transformation than the membrane between them, the wavy shape of the lines would thus be explained.

The author adds "At first my suggestion about the formation of the pattern in such a manner may seem to be strange, and perhaps not admissible. But in thinking over the subject again and again, I have found more and more support for its adoption." He further refers to the authority of Prof. C. Semper in proof of the existence of obstacles in the streams of blood, and to the dark coloration round the nipple of pregnant women as a proof of the appearance of dark colour along an accelerated circulation.

The colours of the patterns are dermal colours. They may, and in fact do, often cover the whole insect. All colours, the pattern

excepted, are hypodermal colours. The dermal colours are formed during the transformation before the integument becomes rigid. The hypodermal colours are formed either after this period or as a main colour in previous stages, just after hatching, before any pattern exists.

After a discussion of mimicry in colours, the nature of colour and its formation is dealt with, the author's view being that it is probable that the colours of insects are chemically produced by a combination of fats or fat acids with other acids or alkalies by the influence of air, light, and heat.

The author's "final conclusions" are as follows.

"1. That some colours of insects can be changed or obliterated by acids. 2. That two natural colours, madder-lake and indigo, can be produced artificially by the influence of acid on fat bodies. 3. As protein bodies in insects are changed into fat bodies, and may be changed by acids contained in insects into fat acids, the formation of colours in the same manner seems probable. 4. That colours can be changed by different temperature. 5. That the pattern is originated probably by a combination of oxygen with the integuments. 6. The mimicry of the hypodermal colours may be effected by a kind of photographic process.

In comparing these still insufficient data with the statement—that colour and pattern are produced in a purely mechanical manner, and are the consequences of natural selection, of adaptation, and of inheritance—we must, if we want to go beyond belief, directly exclude inheritance, as after the statement of Prof. Weismann himself, it is entirely unknown how inheritance works; even the question itself is still entirely untouched. We must further exclude natural selection and adaptation, as both are (according to Prof. C. Semper) only able to begin to work after pigment is produced and after a change of the pattern has begun.

What is then left to justify our accepting a purely mechanical manner but the simple belief that it is so?

I am convinced that colour and pattern are produced by physiological processes in the interior of the bodies of insects."

Development of the Excretory Generative Ducts in Insects.*—The types examined by J. Nusbaum in his study of this subject are the Pediculina, *Lipeurus bacillus* and *Goniocotes hologaster*, and the Cockroach, *Blatta orientalis*. His conclusions are stated as follows:—1. The assumption is incorrect that the posterior cords of the rudiments of the sexual glands unite with each other and form the origin of the whole excretory channel; these cords only form the vasa deferentia or oviducts. 2. All the other parts of the excretory apparatus, viz. uterus, vagina, receptaculum seminis, ductus ejaculatorius, penis and accessory glands, arise from the dermal epithelium. 3. The outer connective-tissue sheaths and the musculature of the excretory apparatus originate from the mesodermal cells of the body-cavity. 4. The excretory passages commence as paired germs. All unpaired parts (uterus, penis, receptaculum seminis, azygos glands, &c.) arise from paired rudiments. The unpaired excretory apparatus of Insects must

* Zool. Anzeig., v. (1882) pp. 637–43.

therefore be considered morphologically as a secondary and more complex system. 5. The male and female excretory ducts of the generative glands are homologous. 6. The cavities of the oviducts, uterus, and vagina in the female, and of the vasa deferentia, accessory organs, and ductus ejaculatorius in the male arise independently of each other and only come into connection in a secondary manner. A full account, with illustrations, of the investigations made by the author in the different orders of insects is to be published hereafter.

Anatomy and Development of the Ovary in Diptera.*—In insects generally, A. Jaworowski finds that each ovary is developed from a single embryonic cell which in *Chironomus* lies between the body-wall and the intestine; in a freshly-hatched larva of this gnat the gland contains two cells, imbedded in the protoplasm of the embryonic cell; the two cells become four and multiply by endogenous production of daughter-cells; each mother-cell becomes an ovarian tubule; daughter-cells sometimes become mother-cells. The tubule is formed by the aggregation of the protoplasm most abundantly around the daughter-cell which is to lie at the distal end of the tubule; this cell grows rapidly and its protoplasm becomes granular; it pushes outwards the cell-membranes of the mother-cell and itself breaks up into daughter-cells, forming the first ovarian chamber; a similar process is repeated for the second chamber, and so on. The excretory tube is formed from a primary mother-cell. The epithelium of the ovarian tubules is homologous with the ova and the yolk-forming cells. The muscles which unite the tubules are produced from small cells which are developed from the remains of the protoplasmic matrix out of which the primary mother-cells originate. The terminal filaments of the tubules have the same structure as the tubules; they end cæcally, and may either be attached to other organs, or be united by muscle-fibres, or end freely.

In the larvæ of *Cecidomyia*, the primary mother-cells do not form ovarian tubes, but become free and pass into the body-cavity, forming the "pseudova" of Leuckart, which are in reality sexual glands.

Systematic Characters of the Labrum of Syrphidæ.†—J. Gazagnaire gives an account of the characters of the labrum in this group of the Diptera, describing a special method of articulation, due to a want of chitinization, which appears to characterize these forms, and points out the generic differences which obtain between *Ceria*, *Eumerus*, and *Volucella*. The present series of studies is confined to native forms, but the author's observations on exotic Diptera lead him to believe that the characters indicated have a general significance.

Genital Organs of the Orthoptera.‡—A. Berlese, as briefly reported, has studied species belonging to all the six families of this order, taken in its restricted sense, viz. *Mantidæ*, *Locustidæ*, *Gryllidæ*, *Gryllotalpidæ*, *Truxalidæ*, *Acrididæ*.

Of the *female* organs, the ovipositor is made up of three pieces,

* Zool. Anzeig., v. (1882) pp. 653–7.
† Comptes Rendus, xcvi. (1883) pp. 351–3.
‡ Atti Accad. Lincei (Rome) Transunti, vi. (1882) pp. 201–3.

and in some families also of a *capsule*, now described for the first time, and derived from the 9th lower arch (sternite); the ovipositor is supplied with 32 muscles. The generative organs receive their nervous supply from the last ganglion of the chain, their aeration from the last stigma. Of the *male* organs, the 9th lower chitinous arch forms the falciform piece, alæ, squamula, &c., between which the penis is extruded; the secretions of the seminal and accessory glands enter the penis by a common canal.

Male Genital Appendages of the Saltatory Orthoptera.*—The externally visible segments of the abdomen which in these insects are accessory to the generative organs are (1) the 9th in the male and 8th in the female, the sternite of which forms the sub-genital lamina; in the males of the *Acrididæ* it is often divided transversely, or it carries (in the *Locustidæ*) two mobile appendages articulated to its lateral angles; (2) the 11th, of which the tergum forms the supra-anal lamina. But these are not the only segments connected with these organs; A. Targioni-Tozzetti finds that by raising the supra-anal and depressing the sub-genital lamina, by which the more internal parts are somewhat everted, a succession of folds are clearly seen, provided with projecting margins of different shapes, which must be regarded as representing the tergal, sternal, and lateral parts of as many more or less complete somites. Of these inflected somites, the tergite of the 1st is tridentate in *Caloptenus italicus*, and that of the 2nd is chitinized and bilobate in *Pachytylus nigrofasciatus*, and these tergites evidently correspond to the organ termed *titillator* by Brunner von Wattenwyl, since the tergite and sternite of the last projection subdivide and combine to form the penis, which is of complicated structure in both species. In *Decticus* and *Ephippigera* the number of inverted folds and of segments included by them is smaller, and the penis is reduced to two sternal valves, which are broad at their base and terminate in two stiliform appendages. These arrangements dispose of the homology between the penis and the upper median portion of the interior of the ovipositor of female *Locustidæ*, supposed by Chadina to exist; and the elements of the penis are, at any rate in the *Acrididæ*, rather to be connected with the styles of the female armature, represented in *Locustidæ* by the lateral valves of the ovipositor.

Circulation of Blood in the Larva of Hydrophilus.†—An examination of living larvæ of *Hydrophilus* under the Microscope by Mr. G. Dimmock revealed the circulation of blood in their antennæ and trophi, which is distinctly visible and curious in its directions.

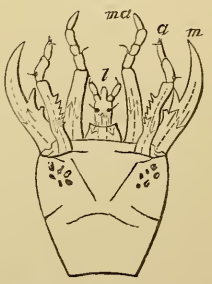
The blood, after leaving the anterior extremity of the dorsal vessel or heart and entering the head, divides itself into two lateral branches, one of which descends on each side of the œsophagus, the two branches reuniting beneath the œsophagus, a little anterior to their division on its upper side, to form a median stream. Between the point where the streams separate and reunite, each gives off three branches, all of which flow in the same direction as the middle stream

* Bull. Soc. Entomol. Ital., xiv. (1882) pp. 384–5.
† Psyche, iii. (1882) pp. 324–6 (1 fig.).

formed by the reunion of the two lateral ones, that is, toward the anterior part of the head. The median stream which is, of course, more ventral in position than the six others, enters the middle of the labium, and passes along the dorsal half of that organ until it nearly reaches the bases of the labial palpi. Here the stream turns back laterally and ventrally, so that the returning current is along the ventral half and in both lateral portions of the labium. Each of the two streams of blood next toward the dorsum from the one which supplies the labium, enters the outer side of a maxilla, flows along the outer side nearly to the distal end of the basal joint of the maxilla, and returns along the inner side of the joint to the head. The two streams next in order, as the dorsal side of the head is approached, are those that supply blood to the mandibles. Each enters the mandible on its inner side, flows nearly to its tip, and returns on its outer side. Dorsally to the currents supplying the mandibles are those that flow into the antennæ, which, in the larvæ of *Hydrophilus*, are used as trophi. Each stream enters its antenna on the inner side, flows to the distal end of the basal joint, and returns on the outer side of that joint to the head. After their return to the head, the currents from the antennæ and trophi are lost among the muscles of the head.

Fig. 35 gives a more readily comprehensible idea of the direction and extent of the streams. To complete the figure one should imagine a stream of blood toward the head, beneath the arrow in the middle of the labium; that is, with the head in the position indicated in the figure, the Microscope can be focussed first on a stream flowing outward in the labium, and then with the fine adjustment, the tube can be lowered until a return stream toward the head is brought into focus. The currents of blood in the head are not indicated, as they would too greatly complicate the figure.

Fig. 35.



Dorsal view of head of young larva of *Hydrophilus ? piceus*. Direction of blood-currents in the appendages indicated by arrows. Dotted lines indicate partitions between blood-currents. *a*, antenna; *m*, mandible; *ma*, maxilla; *l*, labium. × 20.

As the currents are not, of course, confined in arteries and veins, as in vertebrates, the terms streams and currents of blood are used. These streams occupy nearly the whole interior cavity of the appendages in the larvæ, the outward and return currents being separated by partitions, of apparently a porous nature, which are represented in the figure by dotted lines. These partitions, like those described by Carus * in the abdominal appendages of the larvæ of *Agrion puella*, are very delicate, and extend, in the antennæ, mandibles, and maxillæ, from the upper to the lower chitinous walls. In no case have corpuscles of blood been observed to pass through

* Carus, C. G., 'Entdeckung eines einfachen vom Herzen aus beschleunigten Blutkreislaufes in den Larven netzflüglicher Insecten.' Leipzig, 1827.

these porous partitions, but they may not be impervious to the fluid portion of the blood. They serve to guide the currents of blood and to cause it to circulate in the appendages. It is not necessary for these porous partitions to extend into the apical joints of each appendage, the blood which fills these joints not needing rapid changing. Carus notes that, in the larva of *Ephemera vulgaris*, the blood has a distinct outward and return current in the basal joint of each antenna. This is the case, as will be seen by the figure, in the antennæ of the larva of *Hydrophilus*, where the partition between the two streams ends just posterior to the distal end of the basal joint of each antenna.

Verloren * notes that, in the antennæ of the larvæ of *Ephemera diptera* he had never been able to observe the circulation of the nutrient fluid, except in the first joint, where the current enters on the inner side and returns on the outer side. The direction and extent of the currents of blood in the antennæ are the same in the larva of *Ephemera diptera* as in that of *Hydrophilus*, but, as the literature at the author's command fails to give the necessary data in regard to the currents of blood in the antennæ of other insects, and he was not able to obtain specimens suitable for further observations, it is unsafe to predict that the currents in the antennæ of insects generally follow a similar course.

It will be seen by a glance at the figure that, with one exception, all the streams of blood have their outward course on the inner side of each appendage; the exception is in the maxillæ, where the outward course of the blood is on the outer side. It would be interesting to know if, in other insect larvæ, the streams of blood entered the maxillæ on the outer and returned on the inner side.

As the circulation in the appendages of the head of the larvæ of *Hydrophilus* has no capillaries, the progress of the blood is so little checked that one can count the pulsations of the heart as well in the returning currents as in the outgoing ones.

For the purpose of detailed study of the circulation of the blood not only in the antennæ and trophi but in all parts of the body, the young larvæ of *Hydrophilus* offer special advantages, on account of their transparency, which is so great that their blood-corpuscles can be readily seen under the Microscope, without using extremely high powers. The egg-cases of *Hydrophilus* can be collected in summer, and the larvæ easily reared in a small aquarium. If a suitable aquarium be chosen, and placed beneath any kind of a fly-trap, in such a way that the flies captured will fall, living, into the water, a healthy brood of larvæ of *Hydrophilus* can be fed with a minimum of attention.

β. Myriopoda.

Ventral Organ of Geophilus.†—The gland which emits a red liquid by certain disks in the median ventral line of *G. Gabriellis* has been studied by N. Passerini. The disks are epidermal structures about 0·2 mm. in diameter in adults, and are placed in slight depressions of

* Verloren, M. C., 'Mémoire en réponse à la question suivante: Eclaircir par des observations nouvelles le phénomène de la circulation dans les insectes,' 1844.

† Bull. Soc. Entomol. Ital., xiv. (1882) pp. 323–8.

the integument, one on each foot-bearing segment; their centre is occupied by about 100 glistening bodies, which are the truncate ends of a corresponding set of conical mouth-pieces belonging to long ducts, each of which leads from a long pyriform gland. This gland is called unicellular by Passerini; its basal membrane, which is very thin, contains a number of smooth and striated fibres, which ramify, anastomose, and form a reticulum, and are connected similarly with those of the neighbouring glands, and extend over the ducts. The larger fibres, some of which measure 0·012 mm. in diameter, start from common centres. The fibres very often exhibit a succession of slight inflations, and are evidently contractile and intended to compress the gland and expel its contents. The system of glands belonging to one segment is invested by a delicate membrane containing weak fibres and surrounded by adipose cells, and is innervated by nerve-branches derived from the anterior nerve of the pair which is given off on each side by the ganglion of the segment; the tracheæ belong to a branch which comes direct from the main trunk.

The liquid contained in the gland coagulates promptly in the air, has an acid reaction and taste, and irritates the tongue, is soluble in water and alcohol and becomes whitish under the action of caustic potash; the coagulum shows under the Microscope an amorphous mass containing elongated crystals, which generally form rosettes about 0·14 mm. in maximum diameter; analysis shows its composition to be analogous to that of silk. The only direct evidence as to the function which the author was able to obtain was that when the back is mechanically irritated, the animal turns up its ventral surface, and the disks become covered with the fluid, the object of which seems to be retaliation.

γ. Arachnida.

Polymorphism and Parthenogenesis in Acari.*—A. Berlese states that the adult *Gamasus*, like all parthenogenetic forms, produces viviparously hexapod larvæ; from these are produced nymphs, which never develope ova till they reach the mother-stage. Both the larvæ and the nymphs are distinguishable by their soft hyaline epidermis, and the complete absence of any reproductive organs. There are nymphs which ought to become males, and others which should become females; and this, which is the most frequent arrangement, may be spoken of as the normal series. In addition, there are individuals which cannot be produced by the adults or the higher forms of the series, but they are derived from two distinct groups, which, like the adults, are of the ordinary, or of the extraordinary series. On the other hand, the higher forms may be derived by metamorphosis from lower forms of the extraordinary series. Thus *G. tardus* produces a special larva from which, by rapid metamorphosis, there is developed a larger, octopod nymph. During the whole of its development this form is octopod and asexual; it moults as it grows, but does not seriously alter in form; at the later moults a slight difference may be detected between the future males and females, but there are no traces of any secondary sexual characters.

A detailed account is given of the metamorphosis of *G. tardus*,

* Arch. Ital. Biol., ii. (1882) pp. 108-29 (1 pl.).

G. coleoptratorum, *G. stabularis*, and *Trachynotus inermis;* in the last of these pædogenesis is especially well marked.

Trombidium fuliginosum.*—H. Henking, after stating his belief that Pagenstecher, in his well-known monograph, was dealing with this species, and not with *T. holosericeum*, describes the saccular glands in the last joints of the legs which afford a secretion which appears to enable the animal to move on upright smooth surfaces. After describing the tracheal system and the air-chambers connected therewith, the structure of the sucking apparatus, and the bi-lobed nature of the "liver-stomach" are pointed out, and the presence of large club-shaped cells in the walls of the latter described; some of these, in addition to their granulated protoplasm, have a more or less large number of dark granules, which are most numerous at the free end; as they increase, the tip of the cell becomes sharply separated off from the clearer part of the cell, undergoes constriction, and becomes completely distinct, falling into the cavity of the stomach. Around this organ the cells of the fat-body are regularly arranged.

In the nymph and in the prosopon we find in the middle line and in the anterior dorsal region, close to the eyes, a chitinous structure containing three spaces; these are the protective chambers of a sensory organ. The structure of these parts is described, but no opinion is offered as to their function. The legs are provided with tactile setæ, which are especially well developed in their terminal joints, and are connected with a large tactile ganglion; a tactile ganglion is also found in the terminal joint of the maxillary palp.

The author is of opinion that Pagenstecher has mistaken the sexes, and that what he took for males are females, and the females males. The spermatozoa are oval, plano-convex bodies, without any tail, and appear to move by means of a membrane. The structure of the male organs is described, attention being directed to the complicated chitinous penis, and the vacuolated cylindrical cells found in the tube which opens at the root of that organ.

A new nomenclature is suggested for the various stages of the complicated life-history of these forms; the egg-like stage from which the nymph is developed, is called the *nymphochrysalis*, that from which the perfect animal is formed the *teleiochrysalis*; the egg-membrane, called by Claparède the "Zwischenhaut," is denominated the "apoderma." When this last appears, the Acarus passes into the *Schadonophan*-stage (σχαδών = larva), the *nymphophan*-stage, or the *teleiophan*-stage. When the apoderma disappears the separate forms become respectively larva, nymph, or prosopon (adult). It may be convenient to give the diagram by which the author illustrates these stages.

Quiescent Stages.			Loss of the Apoderm.	*Free-living Stages.*
1. Egg.	Apoderm.	Schadonophan-stage.		Larva.
2. Nymphochrysalis.		Nymphophan-stage.		Nymph.
3. Teleiochrysalis.		Teleiophan-stage.		Prosopon.

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 553–663 (3 pls.).

The history of development is then dealt with in considerable detail, and we find in the larva that the mouth-parts and the digestive apparatus are very similar to those of the adult, that there are two pairs of salivary glands, a paired rudiment of the genital organs, and in addition to the paired double eye, sensory setæ on the legs, and a double pair of setæ between the eyes. The six-footed larva passes by a metamorphosis into a second free-living asexual form, the nymph, and this into the sexually mature prosopon. The larvæ may live for a long time in water, and ova may there undergo their normal development. The nymph and prosopon are carnivorous, living chiefly on Aphides; in seizing their food they make use of their cheliceræ and maxillary palps.

δ. Crustacea.

Ecdysis of Apodemes in Crustacea.*—F. Mocquard, attracted by the recent statement of Vitzen that the apodemes, with some other parts, preserve their ordinary relations on the ecdysis of the lobster, notes that he has observed in the exuviation of the spiny lobster, that the arcades formed by the mesophragms, and the longitudinal branches connected with them are broken, just as much as are also the endothoracic arcades and the paraphragmal pieces of the endosternites. In other words, all the connections between the mesophragms of the two sides, or of the same side, as well as of the paraphragmal and internal branches, are destroyed at the moment of ecdysis; and this destruction is prepared for by a decalcification and softening of these parts.

In the lobster, where the arrangements are a little different, we find likewise a division of the mesophragms along the middle line, and the separation of the branches of the endopleurites from those of the endosternites. Similar solutions of continuity may probably be detected in the apodemes of the Brachyura.

Blind Copepod of the Family Harpacticidæ.†—The interest now centering upon those animals which, through peculiarities in their habitat, have dispensed with important organs, warrants, Mr. C. L. Herrick thinks, the mention of a case of the disappearance of the eyes in an order of Crustacea in which it has not been hitherto noticed, so far as he knows.

While collecting marine Copepoda in the Gulf of Mexico, a gathering was taken from a very slightly saline marsh, a ditch passing through the marsh affording the only water of sufficient depth in which to use the net. This ditch, about 18 in. in breadth, but of very moderate depth, extends continuously for some distance, and was so shaded by high salt sedge-grass as not to be found save by accident. The gathering proved to contain a new species of the sub-family Longipediinæ, and closely allied to the genus *Bradya* established by Boeck in 1872 for a marine copepod dredged in rather deep waters about Northern Europe.

The American species, which has been named *Bradya limicola* in

* Comptes Rendus, xcvi. (1883) pp. 204–5.
† Amer. Natural., xvii. (1883) p. 206.

allusion to its muddy habitat, was found to lack in both sexes the pigmented eyes which in other Harpacticidæ are so conspicuous in the centre of the forehead or on either side. It is to be regretted that lack of opportunity to repeatedly collect this interesting species, and to endeavour to ascertain if truly pelagic species also inhabit American waters, robs this discovery of much of its interest.

Vermes.

Mode of Application of the Suckers of the Leech.*—G. Carlet has investigated this somewhat difficult matter by the use of the graphic method. He finds that, if a leech be placed on a sheet of smoked paper, it progresses by the alternate fixation of the anterior and posterior suckers. That of the hinder one is made very simply and rapidly; the circumference being first applied, and then the central portion. That of the anterior is more complicated and less rapid; the leech commences by exploring the place to which it is going to fix itself, with the two sides of its upper lip; the anterior portion of the upper lip is then lowered, and then the lower lip is applied to the surface. The pharynx begins to be lowered, and the triangular contour of the sucker gradually becomes circular. The sucker then touches the paper in its centre. From these observations it would follow that, instead of beginning to fix itself by the centre of its sucker, and then depressing the edges, as has been generally believed, it is the edges which are first applied, and the centre which is last. When the leech detaches itself the edges are first raised, and then the centre.

Spermatogenesis in the Nemertinea.†—A. Sabatier finds that in the Nemertinea the seminal sacs give rise to spermatospores or "male ovules," composed of a mass of finely-granular protoplasm, in which a nucleus may or may not be apparent. The central portion of the protoplasm tends to atrophy, while the peripheral portion separates from it, tends to become independent, and to form spherules which become attached to the internal wall of the sac. The central portion is called the protoblastophore, and the peripheral spherules the protospermoblasts. In the peripheral or superficial layer of these last there arise, endogenously, numerous granulations, which are larger than the primitive granulations of the protoplasm. The appearance of these is to be correlated with the division of the peripheral protoplasm into small regions, which constitute the deutospermoblasts; and of these the central granulation and the protoplasm elongate to form the spermatozoa. The central portion of the protospermoblasts adheres to the wall of the sac, and gradually undergoes atrophy and disappears; it is the deutoblastophore. Attention is directed to the exact and complete parallelism which there is between the spermatogenesis of Nemertines and Annelids; although in the former we observe certain peculiarities which teach us the significance of the nucleus and of the protoplasm. It is the peripheral portion alone which becomes converted into the spermatozoon; the

* Comptes Rendus, xcvi. (1883) pp. 448–9.
† Rev. Sci. Nat., ii. (1882) pp. 165–81 (3 pls.).

nucleus, where it exists, and the central portion undergo atrophy. It is possible, therefore, that we may be able to distinguish in every cellular element an antagonism or difference in polarity between the central and peripheral portions. These polarities are sexual in character, the central corresponding to the female, and the peripheral to the male. The two polarities have an attraction for one another. Every cell in which they are maintained in equilibrium is a neuter-cell; it is a complete element, in which nothing is wanting, and which is capable of reproducing itself without any external influence, provided only that it be young enough and have sufficient nutriment. Every cell in which the equilibrium is destroyed becomes a sexual cell, with a predominant polarity; and this result may be due to a modification in its nutrition and development. We see therefore that every cell which loses its central element becomes a male, and every one in which the central portion is predominant becomes a female cell. Further evidence in support of these propositions is promised.

Pilidium-Stage of a Nemertine.*—Mr. E. B. Wilson describes the Pilidium stage of a nemertine. It is helmet-shaped, with the convex side more elevated than usual, and crowned by a small flagellum. The anterior margin of the bell is produced into four short arms, behind which is a deep sinus, followed by two arms on each side, the anterior largest of all. The bell is transparent, its walls and lobes very contractile, and its outer and inner surfaces covered with cilia, which are longest on the margins of the lateral lobes. The young nemertines are developed in a folded position, within the lower and posterior part of the larval envelope, and are distinctly segmented posteriorly.

Tæniadæ Parasitic in Birds.†—H. Krabbe has notes on 42 species, of which 16 are new. A few synonyms are indicated, and a list, arranged according to the systematic classification of birds, is given of the forms herein described.

Dicyemidæ.‡—C. O. Whitman closely criticizes (and denies) the accuracy of E. van Beneden's statements that each Cephalopod has a single species of *Dicyema*, and that the species found in closely allied Cephalopoda are much more nearly related than those found in species belonging to the different families. He sets himself to show that "one species of *Dicyema* occurs in at least two different species of Cephalopod, while another is found in at least three different Cephalopods"; that in *Eledone moschata* and *Sepia officinalis* there are in each two species of *Dicyema;* and that of these two (one in each species) differ less from one another than from the species with which they are respectively associated. He proposes to distinguish the Dicyemids by the number of "polar cells," or cells in the head, and to speak of that in which there are eight cells as *Dicyema*, and that in which there are nine as *Dicyemmennea*. It will be remembered that van Beneden made four genera. Systematic descriptions of

* Amer. Natural., xvii. (1883) pp. 94–5.
† Vid. Selsk. Skrift., i. (1882) pp. 349–66 (2 pls.).
‡ MT. Zool. Stat. Neapel, iv. (1882) pp. 1–89 (5 pls.).

these, of which there are seven in the first, and three in the second genus follow; and then succeeds a chapter on Reproduction, in which the author affirms his belief that the now well-known Rhombogen and Nematogen forms are "two consecutive phases in the same individual cycle of life." The evidence in favour of this doctrine is, however, of necessity, indirect; and it is therefore given in detail. The first doubt as to the accuracy of van Beneden's distinction was raised by the discovery of the fact that, in some cases, representatives of only one class were to be seen in a given Cephalopod. Further, it was found that both forms arise from vermiform embryos, which, so far as one can predict, may give rise to either one or the other.

The rhombogenic mode of reproduction alone gives rise to a plurinucleated axial cell; the two kinds of embryos produced by diphygenic individuals arise from two distinct kinds of germ-cells, both of which originate, in succession, in the Infusorigen. First, we have those which are destined to form infusoriform embryos; the remaining cells give rise to vermiform embryos, by multiplication by division. Like preceding observers, Mr. Whitman has failed to detect any fecundation.

In dealing with the systematic position of the Dicyemidæ, the author cites those authorities who regard them as being degraded Worms; and, discussing the evidence of Julin, states his conviction that that author has demonstrated the existence of a veritable mesoderm; the two intermediate cells derived from the two poles of the endodermic cell are really mesodermic, and their presence justifies us in asserting that there is a "transient triploblastic stage" in the Dicyemidæ. Further evidence in support of the view that these forms should not form the basis of a group of Mesozoa, is to be found in the fact that they are all parasites. "When we find an animal in the form of a simple sac, filled with reproductive elements, secured by position against enemies, supplied with food in abundance, and combining parasitism with immobility, we have strong reasons for believing that the simplicity of its structure is more or less the result of the luxurious conditions of life which it enjoys, even if its development furnishes no positive evidence of degradation." The Dicyemidæ would appear, then, to be Platyhelminths degraded by parasitism, but whether descended from *Dinophilus*, or the Trematoda, further investigations must decide.

It is of interest to observe that there appears to be a striking correspondence between the age of the host, and the reproductive phenomena of the parasite. Nematogenic individuals are commonly, and sometimes exclusively, the guests of young Cephalopods; while in older forms of these Molluscs the rhombogenic is the predominant or sole representative.

Rotifera without Rotary Organs.—The most striking characteristic of the Rotifera is the possession of rotary disks; yet it appears that species exist that have all other characters of the class, but are devoid of vibratile cilia. The first to notice this was Dujardin, who, in 1841, gave the name of *Lindia torulosa* to his discovery. Gosse, in 1851, described a form (*Taphrocampa annulosa*) with similar

characters. Doubt was thrown upon these observations, but Dr. J. Leidy has recently * added to the list of non-ciliated rotifers, and brought together the scattered information upon the subject. In 1857,† Dr. Leidy described a rotifer-like creature quite different from those before mentioned, and having a large protractile pouch or cap in lieu of the usual rotary disks. This he named *Dictyophora vorax.* Still another species (*Apsilus lentiformis*) was described by Mecznichow in 1866; and another (*Balatro calvus*), parasitic upon worms, was observed by Claparède in 1867. In 1882 Mr. S. A. Forbes described a form which Dr. Leidy suspects to be identical with *Dictyophora vorax.*

The last discovery of Dr. Leidy is a rotifer in which a sort of head, in the form of a cup prolonged at the mouth into an incurved beak, takes the place of the rotary disk of ordinary rotifers. This creature, which is named *Acyclus inquietus*, was found occupying a central position among a group of the rotifer *Megalotrocha alba*, both parasitic upon a *Plumatella.* This species is considered by Dr. Hudson, *ante*, p. 161.

Echinodermata.

Supposed Coral-eating Habits of Holothurians.‡—Mr. W. S. Kent, from a study of *Cucumaris communis* and *C. pentactes*, is able to say that the Holothurians do not subsist on living coral. The oral tentacula in both these species are largely developed, taking the form of ten extensively ramifying pedunculate plumose or dendriform tufts, stationed at equal distances around the oral opening. It is with these organs that the food substances are seized and conveyed to the alimentary system, though in a manner totally distinct from what obtains in other tentaculiferous animals, such as a sea-anemone, tubicolous annelid, or cuttle-fish. When on the full feed, it was observed indeed that the tentacles of the Holothurian were in constant motion, each separate dentritic plume in turn, after a brief extension, being distally inverted and thrust bodily near to its base into the cavity of the pharynx, bearing along with it such fragments of sand and shelly matter as it had succeeded in laying hold of. No consecutive order was followed in the inversion of the separate tentacles, that which at the moment had secured the most appetizing morsel gaining seemingly the earliest *entrée.* But little time was lost in this feeding process, for no sooner was one tentacle everted than another was thrust into the gullet, and so the meal continued, as not unfrequently observed, for several hours together. To furnish a fitting simile for this anomalous phenomenon of ingestion, one might imagine a child provided with ten arms, after the manner of ancient Buddha, grasping its food with every hand, and thrusting it in a quick and continuous stream down its throat, the hands and arms with every successive mouthful not stopping at the mouth but disappearing up to or above the elbow within the visceral cavity.

* Proc. Acad. Nat. Sci. Philad., 1882, pp. 243–50 (1 pl.). Amer. Natural., xvii. (1883) pp. 212–3.

† Proc. Acad. Nat. Sci. Philad., 1857, p. 204.

‡ Nature, xxvii. (1883) .p 433.

That the Holothurians are not devourers of living corals is shown not only in connection with the data just recorded, but from the fact also that several of these animals were kept in a tank containing sea-anemones and corals (*Balanophyllia verrucosa*) without their interfering with them in any way, or manifesting alimentative functions other than those just described. All that they require for their nutrition is evidently derived from the coral or shell débris with which they are customarily associated. At first sight this material would appear to be in the last degree adapted for the sustenance of such highly-organized animals, but, as may be confirmed at any time by the investigation of like conditions in aquaria, it will be found that shell-sand, gravel, and all other débris forming the superficial layer at the bottom of the water, when exposed to the light, are more or less completely invested with a thin pellicle of infusoria, diatoms, and other microscopic animal and vegetable growths. It is upon these minute organisms that the Holothurians feed, swallowing both them and the shelly or other matter upon which they grow.

Stalked Crinoids.*—P. H. Carpenter has a preliminary notice of the stalked Crinoids of the Caribbean Sea, in which he has notes on some old species, and on others either new or only briefly described by Sir W. Thomson. Some observations on *Holopus* are mentioned, and it is stated that the supposition that the tissues of this form are very imperfectly differentiated was found to be incorrect. The ovaries closely resemble in structure those of *Antedon eschrichti*.

New Deep-Sea Stalked Crinoid.† — Prof. E. Perrier describes the fifteenth stalked Crinoid known to be now living—*Democrinus parfaiti*. This is distinguished by the calyx, which is formed of five long *basals*, separated by a circular groove from the five rudimentary radials; these are surmounted by five pre-axillary radials, with which are connected five arms, which, as in *Rhizocrinus* and *Hyocrinus*, are simple. Of all living fixed Crinoids, *Democrinus* has a shorter transverse calycal axis, in relation to the diameter of the stalk, than any other known form. This fact suggests that the stalk or peduncle is an essential and important element in the determination of the typical Echinoderm. In one example it was noted that the stalk had two sets of roots, and thereby gave some indications of a second stalk with a second calyx. If this view should be shown to be correct, we should here have an example of a colonial or branched Echinoderm. The author refers to the parallel he has drawn between the Echinodermata and the Cœlenterata; and reminds us that the greater number of primitive Echinoderms were fixed; although, as might be expected, they are, like the Cœlenterata, radially symmetrical, we have yet no example of arborescent forms. *Democrinus* appears to diminish this distinction; for, even if they did not live in colonies, they show that the arborescent arrangement may obtain in Echinoderms, as well as in Cœlenterates.

* Bull. Mus. Comp. Zool. Cambridge, x. (1882) pp. 165–81.
† Comptes Rendus, xcvi. (1883) pp. 450–2.

Asterid from Great Depths.*—E. Perrier describes under the name of *Caulaster pedunculatus* a remarkable starfish, taken by the 'Travailleur,' which is provided with a dorsal peduncle, altogether comparable, in position, to the stalk of young Comatulæ, and of adult fixed Crinoids. It is pointed out that while the Crinoids [Pelmatozoa of Leuckart] are always fixed for some period of their lives, it is interesting to find that, among the non-stalked forms, the apparently oldest class may sometimes present a similar arrangement. The two specimens were of unequal size, and the largest had a greater radius of only 5 mm.; in both, the apex of the interbrachial arc is occupied by a sort of cleft, provided with papillæ, and separating the marginal plates of the adjacent arms; the clefts are prolonged on to the dorsal side of the disk, where they have a double row of spines, which converge towards the base of the dorsal appendage.

The marginal plates are not very evident, and are, as in *Ctenodiscus*, arranged in only a single row; there are five of them to each arm. The tubercular madreporic plate is placed in one of the interbrachial clefts. The ambulacral tubes have no suckers, and are arranged in two rows, but there are only eleven pairs of them. The dentary plates are simple scales, which fuse at their free extremity, and are prolonged into a kind of conical unpaired tooth. The dorsal integument is soft, and seems to be without plates of any kind. The dorsal appendage, which is 2 mm. long, is cylindrical, flexible, and granulated on its surface. In the younger of the two specimens we find at its base four large calcareous plates, arranged in cruciform fashion, and each bearing a small spine; a fifth plate, which is opposite to the madreporite, clearly belongs to the same cycle. Five other and smaller plates are set in the free angles formed by the first five. The resemblance between these and the ten plates which form the periproct in the Echinoidea, and those which make up the calyx in the Crinoids is, clearly, very striking. In addition to this, it may be observed that the young of *Leptychaster*, discovered by the 'Challenger,' which are developed in a marsupial pouch, are attached to its walls by the centre of their dorsal surface. On the other hand, the rosette of plates is an embryonic character, and this is in agreement with the view that the Asteroidea are derived from the Crinoidea. Young Asterids and young *Brisingæ* have dorsal plates which, as is now well known, are arranged like those of the calyx of Crinoids; those of the first row, which become converted into the odontophores, cannot be made out in *Caulaster*. The new form is evidently near *Ctenodiscus*, which has a slight dorsal tubercle, perhaps homologous with the appendage of *Caulaster*.

Cœlenterata.

Cyclical Development and Relationships of the Siphonophora†—Dr. Carl Chun finds that in the cyclical development of the species called by him *Monophyes primordialis* there are five stages: 1. Planula.

* Comptes Rendus, xcv. (1882) pp. 1379–81.

† SB. K. Preus. Akad. Wiss., 1882, pp. 1155–72 (1 pl.). Ann. and Mag. Nat. Hist., xi. (1883) pp. 155–69.

2. Embryo with the bud-rudiments of the nectocalyx and tentacle. 3. *M. primordialis*. 4. *Muggiœa kochii*, and 5. *Eudoxia eschscholtzii*. This cyclical development appears to the author to have a close relation to locomotion.

Where numerous energetically acting nectocalyces occur, as among the Polyphyidæ (*Hippopodius*) and Physophoridæ, the sexual animals remain sessile and often degenerate into medusoid gemmæ. Where only one (Monophyidæ) or two nectocalyces (Diphyidæ) produced a comparatively feeble locomotion, the diffusion of the species is provided for by the remarkable process of *Eudoxia*-formation. Nay, it may happen, as shown in the case of *Monophyes primordialis*, that the first nectocalyx is replaced by a second heteromorphous one, which is better fitted to carry along the long trailing stem with the *Eudoxia*-clusters. From the primitive organization of this *Monophyes* the life-history of the species therefore appears to be spread over three generations, proceeding one from the other. Lastly, if, as in the most highly organized Siphonophora the Pneumatophoridæ and Discoidæ, the locomotive organs are wanting, the locomotion takes place only passively, the diffusion of the species is rendered possible by the sexual animals being rendered motile. This is an alternation of generations that intervenes, as an element of polymorphism, in the course of development of the Siphonophora, and indeed of their highest representatives, in this fashion, that on a polymorphic nurse-generation anthomedusæ are produced by gemmation, either females alone (Pneumatophoridæ), or males and females (Discoidæ), which only attain sexual maturity after their separation.

Cœlenterata of the Southern Seas.*—R. v. Lendenfeld gives an elaborate account of *Cyanea annaskala*, a new species very abundant on the southern shores of Australia; in a careful table the differences of the several species of the genus are pointed out, the relation of the breadth of the umbrella to its cavity, and of the former to the breadth of the central stomach, the form of the ephyral lobes, the colour of the umbrella, of the genital organs, and of the "mouth-arms," and the diameter of the umbrella, being the points that are taken for comparison.

Histological examination shows that but few kinds of cells take part in the formation of the animal; not to speak of the great agreement presented by different tracts of the ectoderm, we may note the equal distribution of glandular and flagellated cells in the gastro-vascular cavity. All the sensory cells appear to have the same structure; more striking differences are to be detected between the various ganglionic cells, but this may be largely due to a want of complete information regarding them.

In addition to the rare, exumbral, palingenetic, epithelio-muscular cells there are also transversely striated sub-epithelial, and smooth intra-epithelial muscle-cells. The greatest differences appear to be presented by the structures which are known as supporting or covering cells, for these may be ciliated or not ciliated, flat or cylindrical,

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 465–553 (7 pls.).

regular or irregular, and their protoplasmic contents may likewise vary. In the ectoderm the stinging-cells lie between epithelial cells, while in the endoderm they are found in them. On the other hand, the glandular cells seem to be of the same kind, whether found in the ectoderm or endoderm. The fibrils in the gelatinous layer have two forms; nervous elements may be wanting or be but feebly represented; the nerve-fibres with nuclei appear to be, in the adult, almost completely confined to the boundary between the superficial and sub-epithelium, or between the epithelium and gelatinous layer. The endodermal ciliated cells, which have the same structure throughout the stomach, vessels, and inner side of the mouth-arms, are, on the genital organs, differentiated into flattened or high cylindrical elements, from which the genital products are derived.

In dealing with the sensory cells, the author directs attention to processes given off from their centripetal ends, which are of some considerable thickness, and which give off at their ends fine fibrils, which may be followed for a considerable distance; these are looked upon as nerve-fibrils, and it is stated that in several cases a connection has been observed between a sensory and a sub-epithelial ganglionic cell, by means of such a fibre.

The sensory cells here mentioned resemble those figured by Eimer and the Hertwigs, but are distinguished by the greater length of their tactile setæ. Similarly, a direct connection has been observed between some of the stinging-cells and ganglion-cells, and it is believed that such a connection always obtains. Unlike *Cyanea capillata*, *C. annaskala* has transverse folds developed on its "olfactory groove"; there are ordinarily five or six of these, and they are not very high; but it is more probable that we have here to do with a gustatory than with an olfactory organ. Tufts of radiating fibres may be detected passing centripetally from the marginal bodies, which, gradually becoming more delicate, extend to the region of the circular muscle; here they branch frequently, and form numerous anastomoses. In the young they and their ganglion-cells lie in the epithelial, but in the adult they are found in the sub-epithelial layer. The nerve-fibres appear to have no sheaths. The motor ganglionic cells are distinguished from those of the marginal bodies by their form, for instead of being hemispherical they are stellate; nor do they appear to have that striation of the protoplasm which is to be noted in the others.

All the muscular fibrils which were noticed belonged to the ectoderm; the smooth fibres are always radially arranged, while of the others we may note an unbroken circular muscle, and 16 radial lobe muscles. Like all the members of the genus, *C. annaskala* is beautifully coloured, and the males may be distinguished from the yellowish-brown females by the rosy colour of their genital glands.

Observations on Hydræ.*—W. Marshall commences by stating his belief that the green colour of *Hydra viridis* is not due to a symbiotic process, but is a property of the polyp, and in this he agrees with Prof. Ray Lankester; of this species there appear to be

* Zeitschr. f. Wiss. Zool., xxxvii. (1882) pp. 664–702 (1 pl.).

several geographical races, as the forms mentioned by Baker, Trembly, Rösel, Pallas, and Schäffer, differ a good deal in size, and in the proportionate length of the arms.

The young forms, just set free from their parent, have a remarkable power of movement in the ectoderm; this periodically thickens into tubercles which are best developed in two circular regions, but the number of tubercles is not constant. They may gradually disappear, the hinder ones completely, and the anterior often give rise to a mammæform papilla, which may become greatly elongated and forked at the tip; a little later some of their cells become converted into spermatozoa, canals being given off from the central space protruded by the body-cavity, in which these elements are developed. Still later, the hinder tubercles again become developed, either into buds (spring and summer), or ova (autumn). The author is unable to explain why the male elements appear so much earlier.

It would seem that the buds of *Hydra* were not at first developed in the interest of the species, but that they were merely blind sacs of the body-cavity, which in time became provided with a mouth and tentacles, and were rendered capable of leading a free existence. In an examination of the causes of this phenomenon we have firstly to note that when a *Hydra* is receiving more nourishment than it needs it can only increase in extent by a system of folds, in other words, diverticula are developed. Were these buds developed irregularly on the anterior half of the body, the contractile power of the polyp would no doubt be affected. But these considerations do not explain why the buds get mouths; the explanation of which may possibly be that the body becoming too large, or the supply of food diminishing, the parent animal would no longer be in a position to feed the buds, which therefore, must develope the organs of independent nutrition, and finally themselves break away and become independent of their parents. And it is at any rate certain that, under experimental conditions, the buds do break off earlier if the whole organism is subjected to less favourable conditions of existence.

A review and comparative account of the Hydroida leads to the belief that in *Hydra* we have to do with a form which has been partly degraded and certainly modified in adaptation to its fresh-water habitat.

Development of Renilla.*—The need of further studies on the embryology of polyps in general is apparent to every zoologist; and *Renilla*, as a highly specialized form, presents a number of special morphological problems, which can only be solved by a study of the embryological history of the organism. Mr. E. B. Wilson therefore selected the genus as a doubly desirable object for investigation, and now publishes his results.

The paper is divided into four parts. The first comprises an account of the segmentation of the egg and formation of the germ-layers; the second a description of the formation of the tissues and

* Proc. Roy. Soc., xxxiv. (1882) pp. 384–8.

organs of the primary or axial polyp; the third part treats of the formation of the colony produced by budding from the axial polyp; and the fourth deals with a few theoretical questions suggested by the phenomena observed. The leading points of the paper as now published are abstracted in 22 sections.

Scotch Pennatulida.*—Professor Milnes Marshall and Mr. W. P. Marshall give an important and interesting account of the Pennatulida collected in the Oban Dredging Excursion of the Birmingham Natural History and Microscopical Society; *Funiculina quadrangularis*, *Pennatula phosphorea*, and *Virgularia mirabilis* were the three forms collected.

The very primitive nature of the first of these is indicated by the irregular arrangement of the polyps, their independent insertion into the rachis, and in the comparatively slight difference between the polyps and the zooids, as well as by the shortness of the stalk, or part of the colony devoid of polyps. In *Pennatula*, we have the polyps fused into leaves, and there is a considerable difference in the size of their constituent parts, as well as great anatomical differences between the polyps and the zooids; the stalk is, also, relatively much longer. *Virgularia* is shown to be the most modified by the restriction of the reproductive organs to imperfectly developed polyps, and, in addition to these points, by the presence of the so-called radial vessels which are absent from the other two forms.

A very curious discovery has been made with regard to *Virgularia*: with but one exception, all the known specimens of *Virgularia* are mutilated, the lower end being generally and the upper always wanting; as a hypothesis, the authors some time ago suggested that the tips were bitten off by some marine animals, probably fish. Since then, they have (through Mr. R. D. Darbishire) been able to examine the contents of a stomach of a haddock, which consisted of five fragments of *V. mirabilis*; and of these, three were "actual perfect upper-ends"; as a possible explanation of this mutilation it is suggested that the apparent absence of stinging-cells from this species is not only apparent but real, so that the fish are enabled to bite at them with impunity. As the specimens examined were not in a thoroughly satisfactory condition for histological study, the question must be examined again with more satisfactory specimens.

The evidence afforded by the dredging leads to the supposition, already suggested by Richiardi and Kölliker, that *Funiculina forbesi*, the supposed British species, is only the immature form of *F. quadrangularis*, which is well known from the Mediterranean. The most complete example from Oban is only 39 inches long, but at Hamburg there is a stem 89 inches in length.

Protozoa.

Bütschli's Protozoa.—Parts 14–16 of this work have been issued, and are devoted to the Gregarinida; the plates, however (XXI.–XXVIII.), are still illustrative of the Radiolaria. With regard to

* 8vo, Birmingham, 1883, 81 pp. (4 pls.).

the interesting question of contractile fibrils, it is pointed out that in addition to those in the ectoplasm, first seen by van Beneden, there is a fibrillation between the ecto- and endoplasm (A. Stuart). The question of the mode of reproduction of the free Gregarines (i. e. of those not parasitic within cells) is discussed at great length, under the following heads: (1) Conjugation; (2) Encystation; (3) Form of the cysts, and characters of their envelope, in which is included a note on what Schneider has called Pseudo-conjugation; (4) Sporulation; (5) Further development and structure of the ripe spores; (6) Development of the contents of the spores; (7) Development of Gregarines from spores.

The Sporozoa are divisible into the Gregarinida (S. Str.), Coccidia (oviform Psorosperms), Myxosporidia (Fish-psorosperms), and Sarcosporidia (parasitic tubes).

Observations on Protozoa.*—A. Gruber commences by describing some new forms; of these *Pachymyxa hystrix* is a rhizopod of peculiar organization, the larger specimens of which appear to the unaided eye as small white granules; this body is surrounded by an envelope which consists of closely-applied fine rods, set nearly at right angles to the surface; destroyed by chromic acid and unaltered by osmic acid their chemical composition still remains unknown. At any rate, they are not foreign bodies, but secretions or products of the protoplasm. Between the rods pores may be made out, and through these the pseudopodia may be protruded; in form these are not lobate, but of equal thickness, and of somewhat definite length; they are never observed to branch, and no streaming of the protoplasm was detected in them; nor do they seem to serve as locomotor but only as prehensile organs. The protoplasm within appeared to be excessively viscid, and the only structures that could possibly be regarded as nuclei were some red dots, which may be small nuclei; the relation, or possible relation, of these to reproductive phenomena could not be studied.

This remarkable form does not seem to be allied closely to any known Protozoon; in the formation of its pseudopodia it comes nearest to *Orbulinella;* the envelope with its pores, reminds one of the perforate Foraminifera, while the slightness in consistency and the form of the pseudopodia, no less than the whole structure of the protoplasmic body, indicates an alliance with the amœboid Rhizopoda.

After describing some naked masses of protoplasm found in the sea-water of the same aquarium, the author passes to *Amœba obtecta*, likewise found in the small marine aquarium; small in size, it does not creep about, but forms for itself a home of mucous substance, which hardens in water, and becomes strengthened by the addition of foreign bodies to its surface. Under suitable conditions, a number become associated together, and appear to form a colony.

After an account of *Spongomonas guttula* n. sp., which likewise seems to be colonial, Dr. Gruber discusses the characters of the genus *Stichotricha*, a form of the Hypotrichous Infusorians, which is distinguished by the possession of a defensive envelope for its soft body.

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 45–70 (3 pls.).

Attention is directed to a variety which was coloured green by chlorophyll-granules, and to another in which, in the place of regular, there were developed dendritic tubes. The stiff processes in one form were observed to be able to function either as cilia or as pseudopodia; and the two conditions may succeed one another with great rapidity.

The third and concluding portion of the paper deals with the phenomena of the fusion of several individuals of *Actinophrys Sol.**

New Flagellate—Chlorodesmos hispida.†—Mr. F. W. Phillips records a new form (from pond-water at Hertford) differing so strikingly from all other known forms that it is necessary to institute a new genus for its reception, *Chlorodesmos* (*hispida*).

It is found in colonies of about thirty zooids, grouped together in a chain-like manner, and possibly united by a contractile, hyaline ligament of extreme delicacy. The constituent zooids each inhabit a closely-fitting lorica of a somewhat triangular aspect, pointed anteriorly, and twice the width posteriorly at the point of attachment. The lorica is covered with very minute spinous processes of even length. At the anterior extremity there is a slight indentation, in the centre of which is the oral aperture, which is continued into a short, distinct, triangular, pharyngeal cleft or cavity. Seen from a side view, the lorica has an oval aspect. The flagella are two in number and of equal length, issuing from the pharyngeal cleft. The endoplasm contains the two characteristic lateral pigment-bands; there are no eye-spots; one contractile vesicle is developed posteriorly.

The most remarkable characteristic in connection with these colonies is the peculiar movements, which are of a twofold nature. The first consists of an elongation and corresponding retraction of the whole chain of zooids to about five times the retracted length. During these movements one end of the chain is anchored to some substance, the other floating freely with a worm-like motion; these movements take place at the rate of about three per minute. The second movement is a clapper-like motion, each zooid closing upon the other, like the two shells of a bivalve mollusc; this motion is much quicker than the former, and is irregular, while the former is rhythmical.

Owing to the awkward position of those groups seen, Mr. Phillips has not been able to make out clearly the nature of the supposed elastic integument which unites the zooids, but from a careful examination of the movements he has but little doubt as to its existence.

Chlorogonium euchlorum, Ehrenberg.‡—J. Krassilstchik has studied the *developmental stages* and *resting period* of this form. The young produced from the resting-cells have a brick-red colour at first and do not usually possess a fusiform shape; the green colour of later generations is darker than that of the first, and is produced by granules of chlorophyll. As observed by Stein and Reinhard, pulsating vacuoles occur; of these there may be as many as sixteen, quite

* See this Journal, ii. (1882) p. 800.

† Trans. Hertfordshire Nat. Hist. Soc. and Field Club, ii. (1882) pp. 92–4 (1 pl.).

‡ Zool. Anzeig., v. (1882) pp. 627–34.

small and irregularly scattered. Reproduction takes place by successive fission; the entire contents of the capsule divide into from four to thirty-two parts, according to the generation to which the individual belongs. The cilia persist and the movements of the individual are not interrupted until from fifteen to thirty minutes before the emergence of the young or fission-products, when the cilia disappear; the maternal envelope gradually dissolves, while the young move over each other; they each have a delicate investing membrane. The first generation divide into eight, the second into four (forming the macrogonidia of Cienkowski). About ten days after an infusion is made the results of the division into four themselves divide into thirty-two small individuals (microgonidia); both ends of the latter are usually pointed. There is no morphological difference between the macro- and micro-gonidia, for the shape of both is essentially the same, as is best seen by comparing microgonidia resulting from a division into sixteen with the fusiform macrogonidia.

After a short free existence, the microgonidia copulate in pairs; the pair are usually equal in size, but not unfrequently a large individual unites with a small one; contact is first effected by the anterior cilium-bearing ends; the cells then apply themselves longitudinally to each other, fusing and forming a heart-shaped mass which in from fifteen to thirty minutes ceases moving and has become a globular cell about 0·008 mm. in diameter; the cilia then disappear, and the cell grows to a diameter of 0·013 to 0·015 mm., when it contains a tolerably large green amylone globule and is invested by a strong rigid membrane. Stein has wrongly interpreted certain twin gonidia as showing stages of an act of conjugation, whereas they are distinguishable from copulating gonidia by being united by the middle or posterior, not by the anterior ends, and by the consequent persistence of the cilia. If the round cells produced by copulation are dried and then moistened with water the contents divide into four pieces which form young *Chlorogonia* and become free.

Chlorogonium must be removed from the *Astasiœa* owing to its want of contractility, its developmental history, and manner of fission. It seems referable, as Reinhard has observed, to the *Volvocina*, on the following grounds:—Its possession of an investing capsule, its successive divisions within the capsule, the motion by means of two incessantly active cilia, and the copulation resulting in round resting-cells. It seems especially allied to *Polytoma* by its incessant motion, by several details in the mode of fission, and by the fission first into eight and after that always (except in the last division) into four.

BOTANY.

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

Living and Dead Protoplasm.* — In reply to the statement of A. Mori † that formic aldehyde is the first product of assimilation in plants, O. Loew and T. Bokorny give the following additional arguments in favour of their previous conclusions on this subject.‡ Volatile aldehydes occur in various plants, but only in extremely small quantities; no trace of such a substance was found in *Spirogyra* or any of the other plants under examination. Quantitative examination shows that 100 parts of the dry substance of *Spirogyra* precipitate no less than 47 parts of metallic silver, closely corresponding to the theoretical hypothesis. The fact that the death of the cell from any cause immediately puts an end to the silver reaction, shows that we have not to do with a volatile aldehyde, but that the aldehyde reaction has the most intimate connection with the living condition of the cell. Living protoplasm also yields a product of oxidation with an alkaline silver solution, which is not the case with dead protoplasm. The reagent for aldehyde used by Mori, fuchsin-sulphuric acid, is stated by the authors to be in no way reliable, since, on evaporation of the sulphuric acid, rosanilin is at once produced, which is immediately taken up by the protoplasm.

L. Kraetschmar § contends that the test employed by Loew and Bokorny is valueless, because dead protoplasm also has the power of reducing silver salts. To this Loew and Bokorny reply || that this statement is entirely the result of inaccurate observation. They further state that the silver reduction does not occur with all plants, whether containing chlorophyll or not, nor under all vital conditions in the same organism; it takes place only when the chemical resistance of the protoplasm is so high that the chemical transformation does not take place instantaneously on the first attack on the cell, but advances much more slowly than the disturbance in the organization of the protoplasm.

Continuity of Protoplasm in the Motile Organs of Leaves.¶ — W. Gardiner finds that in a very great number of cases the contracted primordial utricle is connected with the cell-wall by fine strings of protoplasm. In several instances he has observed that many threads go to the pits, and that in two adjoining cells many threads on different sides of a common cell-wall are exactly opposite to one another. When saturated salt solution is added, some of the threads may give way, each free end contracting, one to the main mass, and the other

* Naturforscher, xv. (1882) p. 403; also Bot. Ztg., xl. (1882) pp. 832–5.
† See this Journal, ii. (1882) p. 526.
‡ Ibid., i. (1881) p. 906; ii. (1882) pp. 67, 361, 440, 522.
§ Bot. Ztg., xl. (1882) pp. 675–83.
|| Ibid., pp. 827–35.
¶ Proc. Roy. Soc., xxiv. (1882) pp. 272–4.

to the cell-wall. Attention is also directed to the observation of the passage of protoplasm through the cell-wall when the latter has not been swollen by reagents. In these cases thin sections of fresh material were at once treated with saturated picric acid, washed with alcohol, and stained with aniline blue.

Development of the Embryo of Ruppia and Zannichellia.*—N. Will has examined the history of development of the embryo in these exceptional genera.

In *Ruppia rostellata* the synergidæ of the moderately large and somewhat S-shaped embryo-sac are comparatively small, and soon disappear. After impregnation the ovum-cell divides by a septum into two cells, an upper small one, the future embryo, and a lower one, the suspensor, which soon increases considerably in size, but without dividing. The embryo-cell first divides transversely; the lower of the two cells thus formed then divides longitudinally, as the other one also does later. Each of these four cells then again divides longitudinally; so that the embryo now consists of eight cells, and soon afterwards of sixteen. After this an epidermis or dermatogen is differentiated at an early period. In this stage the embryo consists of a roundish ellipsoidal body, from the upper end of which the cotyledon soon projects. In the depression beneath this is formed the second leaf, and on the ventral side of this latter the third leaf, or perhaps the stem. The cotyledon envelopes the plumule like a sheath. No primary root resembling that of most angiosperms is present, or only a very rudimentary one. In its place a secondary root is formed at an early period, at the base of the cotyledonary sheath on the ventral side, and this root has an exogenous origin.

The development of *Zannichellia palustris* agrees more nearly with that of normal monocotyledons. As in *Ruppia*, the impregnated ovum-cell divides first of all into two cells, of which the upper one again divides by a septum. But here the similarity to *Ruppia* ceases. The two upper cells are again divided by septa, and the upper of these two again divides into four cells by two intercrossing longitudinal walls. Septa then make their appearance, and similar divisions take place later in the lower cell. At this stage the embryo consists of seventeen cells, twelve of them in three layers, then two, which later form a similar layer, then one cell, which subsequently divides and apparently forms the root-cap, one cell which becomes the upper portion of the suspensor, and finally the lower part of the original ovum-cell. Subsequently the suspensor consists of two rows of cells. The cotyledon is formed at an early period, inclosing the first leaves of the plumule like a sheath. The tigellum is very thick and considerably swollen below. *Zannichellia* possesses a primary root.

The author is of opinion that the lower thickened part of the embryo of *Ruppia* is a reservoir of reserve food-material, and that the primary root is aborted, and replaced by an exogenously developed secondary root.

* Videnskab. Meddelelser fra den naturhist. Forening i Köbenhavn (2 pls.), 1882. See Bot. Centralbl., xii. (1882) p. 227.

Plurality of Cotyledons in Persoonia.* — Baron F. von Müller states that in twenty-three out of the sixty-one Australian species of *Persoonia* (Proteaceæ) there are more than two cotyledons, the number varying from three to six. The only previously known example of a plurality of cotyledons among angiosperms is in the genera *Loranthus* and *Nuytsia* of Loranthaceæ.

Division of the Nucleus and of the Cell.†—In his most recent publication on this subject, E. Strasburger describes the mode of division of the nucleus, and the relation of this to the mode of division of the cell itself in the pollen-mother-cells and endosperm of various monocotyledons, especially Liliifloræ and some dicotyledons, the staminal hairs of *Tradescantia*, the tissue-cells of *Asparagus* and *Hyacinthus*, the vegetative cells of *Chara*, *Spirogyra*, and *Œdogonium*, and in some animal cells. The investigation was made chiefly with preparations in alcohol-sassafran and acetic-acid-methyl-green.

The differentiated parts of the living protoplasm Strasburger distinguishes as *cytoplasm* (the cell-protoplasm), *nucleoplasm* (the nuclear protoplasm), and *chromatoplasm* (the protoplasm of the colouring and allied substances). Each of these three modifications is a compound of a hyaline matrix or *hyaloplasm*, and of imbedded granular structures or *microsomes;* so that, by a combination of these terms, we may speak of cytohyaloplasm, nucleohyaloplasm, cytomicrosomes, &c.

The resting cell-nucleus consists of nuclear substance and nuclear sap. The whole of the former is composed of a single very long thread of nucleoplasm, twisted here and there into knots, and suspended in the cavity of the nucleus filled with watery nuclear sap. Towards the cytoplasm this nuclear cavity is shut off, like an ordinary vacuole, by a membrane, the wall of the nucleus, which belongs therefore to the cytoplasm. The nuclear filament consists of a matrix of nucleohyaloplasm with nucleomicrosomes imbedded in it. These latter are distinguished from the cytomicrosomes by their different capacity for receiving colour with specific pigments. The author does not agree with Flemming's description of the nucleus as composed of chromatin and achromatin. Among the nucleomicrosomes are included the nucleoli, which are distinguished from the rest only by their size.

When the nucleus is preparing for division, the nuclear filament first of all contracts, decreasing in length, but increasing in thickness; and the microsomes coalesce into larger granules. Finally the filament consists of alternately denser and less dense plates of microsome-substance and hyaloplasm. The nucleoli disperse into the substance of the filament. The filament now either becomes at once segmented into distinct pieces, or this segmentation takes place later. In the first case the separate pieces, which are attached to the nuclear wall, lay themselves side by side, so that the free ends somewhat diverge.

* N. Zealand Journ. of Sci., 1882.

† Archiv f. mikrosk. Anat., xxi. (1882) (3 pls.). See Bot. Centralbl., xii (1882) p. 259.

In *Salamandra* they form double loops arranged in a wreath. The nuclear wall then disappears, and the cytoplasm enters the nuclear cavity; the loop of the filament becoming usually compressed in the middle, thus commencing the formation of the spindle-fibres. The form of these fibres now causes the adjacent Y-shaped pieces of the filament to arrange themselves into a nuclear plate in such a way that each half of a filament coincides with a side of the plate, and the free ends face the poles. The connection around the fragments of the filament is then broken, and the plate then splits into two halves. In *Salamandra* the double loops open, and each piece divides into two simple loops.

In those cases in which the segmentation of the filament takes place at a later period, it is preceded by the formation of the nuclear plate, several modifications of the process occurring. The nuclear filament always divides eventually into distinct pieces, and each of these again breaks up into two segments, which are distributed one to each side of the nuclear plate. The elements of the still undivided plate vary in form according to the object, from the roundish granular form to that of J- or U-shaped loops. The spindle-fibres approach more or less closely at the poles, where they sometimes coalesce into a "polar corpuscle."

The separation of the two halves of the nuclear plate is preceded by its elements passing from their J- or U- through a C- or S- to a ⊂- or ∩-form. This is effected either directly by the curvature of the polar and elongation of the equatorial end, or by the curvature of the equatorial end extending like a wave to the polar end. During this process a moment occurs in which the spindle has a barrel-shaped form. The author holds that Flemming's description, both of these cases and of *Salamandra*, is in some points erroneous, from his having mistaken the polar for the equatorial view of the nuclear spindle.

The bending of the filaments is followed by the separation of the two halves of the nuclear plate. At the poles the elements first of all approach by their polar ends, resulting in an inbending at the equatorial side, and a coalescence of the separate pieces at both ends. At the same time the whole figure contracts, and a nuclear membrane is formed out of the surrounding protoplasm. The coils of the thread then separate, and nuclear sap is formed between them out of the cytoplasm. The substance of the filament becomes fine-grained, it again becomes longer, the nucleoli again make their appearance as lateral accumulations at the coils, and the nucleus once more enters the resting condition. In the equator of the spindle-fibres which still remain as uniting-threads, and which continue to increase in number by fresh-formed threads, the cell-plate makes its appearance formed of microsomes, and from this is formed the cellulose-wall.

As regards the relation between division of nucleus and of cell, Strasburger somewhat modifies his previous view as to the nature of direct division of the nucleus or fragmentation, that it is fundamentally distinct from indirect division. He now inclines to the opinion that

direct division is the original and simplest mode of division of the nucleus, from which the more complicated modes of indirect division have sprung. In addition to some nuclei, direct division still prevails in chlorophyll-grains. The division of many cells by constriction may also be regarded as an analogous process. All stages of transition between the two modes of division may be conceived, and are in fact presented, in the most various modifications, in the lower organisms. The final development of indirect division depends mainly on the close association of the processes of division of the cell and of the nucleus. When the processes are commenced but not completed, we get multinucleated cells. A peculiar and abnormal case occurs in *Anthoceros* and *Isoëtes*, where the processes of cell-division are adapted to division of a chromatophore and not of the nucleus. Indirect division of the nucleus is initiated by the cytoplasm, as is shown by the simultaneous division of the nuclei in some multinucleated cells, and in the frequent accumulation of cytoplasm around the nucleus which is about to divide. An instructive case occurs in the endosperm of *Galanthus*, where the nucleus which is about to divide is surrounded by an accumulation of protoplasm of fusiform shape and with longitudinal striation, the direction of which corresponds to that of the future nuclear spindle. In direct division he is of opinion that the cytoplasm has no influence whatever.

In the first stage of division of the pollen-mother-cells of *Hemerocallis fulva* it often happens that more than two (from three to seven) daughter-cells are formed. This results from the separate elements, instead of approaching the pole when the halves of the nuclear plate separate from one another, remaining in the equator of the spindle. When the mass of uniting-threads increases, these are subsequently pushed towards the periphery, and there form small independent nuclei, eventually developing into small secondary cells, themselves capable of further division, and thus giving birth to small but otherwise normal pollen-grains.

The first stage of division of pollen- and spore-mother-cells is also characterized by the formation of a "secreting corpuscle." When the nucleoli have just disappeared in the formation of the knots in the filament, a homogeneous, strongly refractive substance usually collects at one, or less often more than one spot at the surface of the nucleus. Its shape is at first lenticular, afterwards spherical, and it lies on the inside of the nuclear membrane. It becomes more and more sharply differentiated from the network of the nucleoplasm, and from the first takes a moderately intense colour from safranin and methyl-green. In its interior are seen small vacuoles. Subsequently it loses its capacity for receiving colour, and decreases gradually in size, until finally it disappears in the cytoplasm when the nuclear plate is formed. It is of uniform occurrence in the pollen-mother-cells of all angiosperms and gymnosperms examined, and in the spore-mother-cells of *Equisetum limosum* and *Psilotum triquetrum*. The secreting corpuscles are possibly analogous structures to the secondary nuclei observed by la Valette St. George and Grobben in the spermatocytes of animals.

Nucleus of the Cells of Secreting Tissue.* — L. Guignard has paid special attention to the constitution of cells containing raphides or other special substances. In the Cycadeæ there are a number of cells in the fundamental parenchyma of the stem and leaves which contain crystals that often increase in size until they occupy nearly the whole cavity. Even when the crystal has attained its full size the deformed nucleus can still be detected, though almost unrecognizable from the pressure to which it has been subjected. In the gum-passages which are distributed through the parenchyma, the cells with delicate walls which surround the cavity contain copious protoplasm in which a nucleus may be discovered, usually applied to the internal wall.

Among Coniferæ, the cells which border the secreting canals are also very active. The nucleus can readily be made out in the protoplasm, by the side of the globules of oleoresin. The same structure characterizes the cells of the secreting canals of Umbelliferæ, Araliaceæ, &c.

With regard to the sieve-tubes of *Vitis*, Cucurbitaceæ, &c., the long cells which form them, and which communicate with one another through their pores, retain their nuclei. When the callus which is formed in winter has not closed the pores, the protoplasm accumulates in the upper part of the cell, and even projects, through the perforations, into the superposed cell; the nucleus is attracted by it, and is sometimes found high up on the lateral wall, sometimes in contact with the sieve.

The nucleus does not appear to divide in the laticiferous cells of Asclepiadeæ, Urticaceæ, &c.

Analysis of Vegetable Tissues.†—E. Frémy classifies the constituents of vegetable tissue under the following seven heads, the characters being derived from their chemical constitution:—(1) Cellulose-substances (cellulose, paracellulose, and metacellulose); (2) Vasculose; (3) Cutose; (4) Pectose; (5) Calcium pectate; (6) Nitrogenous substances; (7) Mineral constituents. The following are some of their distinguishing characters.

1. *Cellulose-substances.* In this group are included all those constituents of vegetable tissues which dissolve without colouring in bihydrated sulphuric acid, producing dextrin and sugar, which are not sensibly altered by alkaline solvents, and which resist for a long time the action of energetic oxidizers. Schweitzer's reagent enables at least the three following varieties to be distinguished:—(1) *Cellulose.* Dissolves immediately in the copper reagent. This constitutes the larger part of cotton-hairs and of the utricular tissue of certain fruits. (2) *Paracellulose.* Dissolves in the copper reagent only after the addition of an acid. This constitutes the utricular tissue of certain roots and the epidermal cells of leaves. (3) *Metacellulose.* Insoluble in the copper reagent even after the addition of acids. It occurs principally in the tissue of fungi and lichens, and in the "fungine" of Braconnot

* Bull. Soc. Bot. France, xxviii. (1881) pp. 332–3.

† Ann. Sci. Nat. (Bot.) xiii. (1882) pp. 353–9.

2. *Vasculose.* This is the substance which enters most largely into the composition of vessels and tracheids. It usually accompanies cellulose-substances, but differs from them completely in composition and properties, containing more carbon and less hydrogen. It is the substance which, in certain cases, unites the cells and the fibres. It sometimes occurs on the exterior of tissues in the form of a continuous resisting and horny membrane. It forms in fact the solid part of woody tissues; it is abundant in hard woods and in the sclerenchymatous concretions in pears; the shells of nuts and the stones of stone-fruit often consist of this substance to more than half of their weight. Vasculose is insoluble in bihydrated sulphuric acid and in the copper reagent; it does not dissolve sensibly at the ordinary pressure in alkaline solvents, but only with the assistance of pressure. This important property is utilized in the manufacture of paper from straw and wood. It dissolves rapidly in oxidizing substances, as chlorine water, hypochlorites, nitric acid, chromic acid, permanganates, &c. Before dissolving it, oxidizers change it into a resinous acid soluble in alkalies. Cellulose-substances can be removed from vasculose by the solvent action on them of bihydrated sulphuric acid or Schweitzer's reagent. If, on the other hand, these substances have to be freed from vasculose, the tissue is subjected for several hours to the action of nitric acid diluted with its volume of water in the cold, which does not act sensibly on cellulose-substances, while it transforms the vasculose into a yellow resinous acid which can then be dissolved out by means of an alkali.

3. *Cutose.* This substance constitutes the fine transparent membrane which forms the surface of the aerial parts of plants; the "suberine" of Chevreul is a compound of cutose and vasculose. It possesses several characters in common with vasculose, resisting the action of bihydrated sulphuric acid; but it is soluble at the ordinary pressure in dilute or carbonated solutions of potassa and soda. It contains more carbon and hydrogen than vasculose. Subjected to the action of nitric acid, it gives rise to suberic acid. To separate cutose from the cellulose-substances and from vasculose, the copper reagent is first used to dissolve the former, and the tissue is then agitated with potassa at the ordinary or at a higher pressure, the former dissolving the cutose and the latter the vasculose.

4. *Pectose.* This substance is insoluble in water, but is dissolved by the action of dilute acids and converted into pectine. It occurs ordinarily in the utricular tissues of roots and fruits, and is recognized by subjecting the tissue with heat to the action of dilute hydrochloric acid; it then forms pectine, which is dissolved in the water and can be precipitated by alcohol.

5. *Calcium pectate.* This salt is often the basis of a tissue which occurs in the form of a continuous membrane, serving, as in the pith of certain trees, to bind the cells together. If this salt is decomposed by an acid, the tissue is immediately disintegrated into its constituent cells. Its determination is effected by heating the tissue in the cold with dilute hydrochloric acid, which decomposes the calcium pectate, leaving the pectic acid in an insoluble state; this is then heated with

a dilute solution of potassa, producing a soluble pectate which can be again decomposed by acids.

6, 7. The *Nitrogenous substances* contained in vegetable tissues are dissolved by alkalies; and the *Inorganic substances* constitute the ash after calcination.

In the most complicated of vegetable tissues, woody tissue, all these substances except No. 6 can be discriminated by using the tests above mentioned. The following is a *résumé* of the action of the reagents named:—Dilute cold hydrochloric acid decomposes calcium pectate, setting pectic acid free, which can then be again dissolved by alkalies. Dilute boiling hydrochloric acid transforms pectose into pectine, which may be precipitated by alcohol. The ammoniacal copper (Schweitzer's) reagent dissolves cellulose. Boiling hydrochloric acid renders paracellulose soluble in the copper reagent. Bihydrated sulphuric acid dissolves the cellulose-substances. Dilute boiling potassa dissolves cutose. Potassa with additional pressure dissolves vasculose. Dilute nitric acid renders vasculose soluble in alkaline solutions.

Chemical Composition of Vegetable Tissues.*—E. Frémy and Urbain have made a series of observations on the chemical constitution of the substances named in the preceding article, chiefly as regards the vascular tissues of plants. For exact details of the numerous analyses made the article itself must be referred to. The following are some of the more general results deduced.

In woods the proportion of vasculose increases with their hardness and density. The proportions of cellulose and paracellulose vary in stems; pine-wood appears to be composed exclusively of paracellulose and vasculose. The parenchyma of the pith often contains considerable quantities of pectose and calcium pectate. Cork consists partly of a peculiar substance called by M. Chevreul "suberine," and composed of cutose and vasculose. In leaves and petals the parenchyma consists of cellulose and pectose, the vascular bundles and vessels of vasculose and paracellulose, and the epidermis of cutose and paracellulose; the utricular tissue of petals is composed almost entirely of cellulose, their spiral vessels almost entirely of vasculose.

In fruits, the epicarp, mesocarp, endocarp, and seed were analysed separately. The epicarp, or skin, of such fruits as the apple is a complex structure composed of three layers; the outermost layer consists of cutose, the middle one of vasculose, and the innermost of paracellulose. The composition of the endocarp is very nearly that of wood, cellulose combined with paracellulose and vasculose; the vasculose sometimes makes up more than half the weight, the endocarp being then extremely hard. The cells of the mesocarp are composed of cellulose, often associated with pectose. The vessels are composed principally of vasculose. The stony concretions of pears are formed of a combination of vasculose and cellulose. The perisperm of seeds, when the starch and the nitrogenous and oily substances have been

* Ann. Sci. Nat. (Bot.) xiii. (1882) pp. 360-82.

eliminated, is almost entirely composed of cellulose. The testa is formed of a mixture of cutose, cellulose, and paracellulose, producing a series of resisting and horny envelopes.

The tissues of fungi, including several species of *Penicillium*, contain large quantities of metacellulose, the "fungine" of Braconnot.

Vasculose is a constituent of almost all vegetable tissues, associated with cellulose; it forms the greater part of vessels and tracheids. In the parenchyma of the pith and in woody tissues it unites together the cells. At the surface of roots and fruits it often forms a continuous transparent horny membrane. The proportion of vasculose corresponds, in general terms, to the resistance or hardness of the tissue. The wood of the poplar contains about 18 per cent. of vasculose; that of the box 34 per cent.; ebony and lignum-vitæ 35 per cent.; iron-wood 40 per cent. The stony concretions of pears, the shell of the hazel, walnut, and cocoa-nut, and the stone of the apricot and peach, may contain as much as 60 per cent. of vasculose.

Vasculose can be obtained in special purity from the pith of the elder. After treating with dilute alkali, it is boiled with dilute hydrochloric acid, in order to transform the paracellulose into cellulose; the ammoniacal copper (Schweitzer's) reagent is then used; and the treatment repeated eight or ten times until no further reaction ensues. The pure vasculose thus obtained preserves a light yellow tint, maintaining the structure of the original tissue.

Vasculose is insoluble in all neutral solvents; it is not altered when boiled with dilute sulphuric, hydrochloric, or phosphoric acid; it resists the action of trihydrated sulphuric acid; it is not changed by boiling alkaline solutions; concentrated sulphuric acid only colours by dehydrating it. It is, however, rapidly changed by oxidizing agents, such as nitric or chromic acid, potassium permanganate, chlorine, bromine, hypochlorites, &c., producing resinous acids. Those which are first formed are not sensibly soluble in alcohol; those last formed dissolve in alcohol, and even in ether. They contain less hydrogen and more oxygen than vasculose. The oxygen of the air at length acts on vasculose, transforming it into resinous acids soluble in alkalies; this being the cause of the change which certain woods undergo in contact with the air. It dissolves rapidly when heated, under pressure, at a temperature of about 130° C., with caustic alkalies. The products are again a series of acids at first insoluble in alcohol; those formed later being soluble in alcohol, and finally in ether. Baryta and lime produce the same result. It is this reaction of vasculose which is utilized in the manufacture of paper from wood and straw. Heated with fused potassium hydrate, vasculose is at once transformed into ulmic acid; cellulose giving rise, under similar circumstances, to acetic and oxalic acids.

One of the principal results of the distillation of vasculose is methyl-alcohol; in the distillation of wood, this substance is in great part the source of the acetic acid. It is well known that those woods which produce, on distillation, the largest amount of pyroligneous acid are the heavy woods, which are therefore most rich in vasculose.

The mean of several analyses of vasculose gives the following composition, C 59·3; H 5·5; O 35·2 per cent.; corresponding to the formula $C_{36}H_{20}O_{16}$. It contains, therefore, more carbon, less hydrogen and oxygen than cellulose.

Cutose is, in its chemical properties, the most interesting of all the substances which make up the skeleton of plants; in its properties and composition it approaches fatty bodies, but differs from them in certain well-defined characters. It constitutes a portion of the epidermis of leaves. Maceration of leaves for a month in water at 30°–35° C. enables the vascular bundles on the one hand and the epidermal membrane on the other to be separated mechanically; a few minutes immersion in boiling hydrochloric acid answers the same purpose. The epidermis thus obtained is composed of three different substances; on the surface is a resinous substance soluble in boiling alcohol; underneath are two other membranes closely adherent to one another, but possessed of different properties; the innermost is composed of a cellulose-substance insoluble in the ammoniacal copper reagent except after the action of boiling hydrochloric acid, consisting principally of paracellulose; the outer of these two layers consists of a special substance, cutose.

The leaves of *Agave* furnish a convenient source of cutose, which can be obtained pure in the following manner. The crude cutose-membrane is first treated with boiling alcohol, which dissolves the resin always present on the surface of leaves; the fatty substances are then removed by ether, and the cellulose-substances are eliminated by trihydrated sulphuric acid; vasculose appears never to occur in the epidermis. Pure cutose, thus obtained, resists the action of strong reagents, such as trihydrated sulphuric acid, hydrochloric acid, ammonia, and cold dilute solutions of potassa and soda; but oxidizing agents and boiling alkaline solutions produce in it interesting modifications. Nitric acid produces first of all resinous substances, and finally suberic acid. Dilute boiling solutions of alkalies and even of alkaline carbonates dissolve cutose and change it into a kind of soap which is soluble in water, but insoluble both in excess of alkali and in alkaline salts such as sodium chloride. The same effect is produced by baryta, strontia, and lime. Two new fatty acids are formed by the action of bases, one solid, the other liquid, which the authors propose to call stearocutic and oleocutic acids. The latter resembles in its character other liquid fatty acids; but the former presents some peculiar properties. It is white, fusible at 76° C., nearly insoluble in cold alcohol and ether, and dissolves with difficulty in boiling alcohol; its best solvents are benzine and crystallizable acetic acid, crystallizing from them in small needles; when once fused it yields on cooling a resinous substance which is no longer crystallizable. Its combinations with alkalies have special properties which are described in detail. The two acids combine with one another under the influence of boiling alcohol, producing a double acid. Attempts to produce the alcohol of the series of either acid have at present entirely failed. It would appear that these two acids are actually present in cutose in an isomeric condition which can be induced by a high temperature,

or even by long exposure to light; in this condition they are insoluble in alcohol, ether, and dilute alkaline solutions.

The resinous substance which covers the surface of leaves soluble in alcohol becomes absolutely insoluble, without changing its composition, by heating above 100° C.

The analysis of the potassa, lime, and baryta salts of these two acids gives the following results:—Stearocutic acid, C 75·2, H 11·7, O 13·1 per cent., or $C_{60}H_{56}O_8$; Oleocutic acid, C 65·6, H 9·4, O 25 per cent., or $C_{28}H_{24}O_8$. Neglecting the small quantities of lime and of calcium phosphate in the cuticle, we may say that it is composed of five equivalents of oleocutic and one of stearocutic acid; giving nearly the percentage composition, C 68·2, H 10, O 21·8.

Cutose occurs not only on the surface of leaves, flowers, fruits, and stems; it penetrates also into the interior of organs, and may constitute as much as 43 per cent. of bark; it is found also in fibro-vascular bundles.

In the process of maceration by which the fibrovascular bundles are separated in hemp and flax, a fermentation is set up accompanied by the presence of amylobacteria, which dissolve the cellulose-tissue that holds the fibres together. The fermentation is of the kind known as pectic fermentation, and results from the development out of pectose of metapectic acid which is soluble in water. The authors suggest that in the important processes of the preparation of flax and hemp fibre, the ordinary mode of maceration may be replaced by a chemical maceration (*rouissage chimique*), by which the pectose or calcium pectate may be converted into metapectic acid, and the cutose and vasculose into resinous acids, and the fibrovascular bundles thus liberated by means of caustic or carbonated alkalies much more economically and advantageously than by the method at present employed.

The subsequent process of bleaching the fibres of flax and hemp depends on the removal of the last traces of cutose, vasculose, and pectose. The last may be advantageously eliminated by means of an alkaline carbonate; the latter by some oxidizing agent such as chlorine, the hypochlorites, oxygenated water, nitric acid, or potassium manganate, and then washing with an alkaline solution to remove the resins formed as the result of the oxidation. This is identical in principle with the ordinary process of bleaching.

The perfectly pure fibres thus separated are composed of cellulose and paracellulose, as is shown by their chemical reactions. They may be obtained from flax and hemp by the methods described, of as great fineness as threads of silk, and they take pigments as well. The authors propose for the substance the name "fibrisoie."

Structure of Leaves in Relation to Nyctitropism.*—In this abstract D. D. Cunningham discusses the "relation of particular structural features in certain leaves to the phenomena of nyctitropism, and movements incident on stimulation by concussion." The con-

* Proc. Roy. Soc., xxxiv. (1882) pp. 268–72.

tractile organs appear to be specially characterized by the porous nature of their component tissues; the more or less complete spongy texture thus developed is fitted to allow of the ready distribution of fluid contents. Where most developed, as in *Mimosa pudica*, there are seen numerous finely porous cells, and masses which, in addition to the fine pores, have one or more large ostiola. Large intercellular spaces are also well developed, and the vascular bundles are characterized by an abundance of porous elements. Local differences in the strength of the formed elements of the tissues, and the amount of protoplasm and of chlorophyll corpuscles are also apparent. It is pointed out that those areas in which diurnal functional activity and the incident increased absorption and tension must attain a maximum, are also those in which greatest facilities for the redistribution of fluids are provided by the nature of the structure. These must, then, on the removal of the light, tend to arrive most rapidly at their passive condition, and the changes consequent on this are probably the cause of the early development of the "maximum nocturnal position."

Transparent Dots in Leaves.*—T. Bokorny has made a series of observations on the transparent dots in leaves, in a large number of natural orders, chiefly belonging to the Gymnospermæ, Monocotyledones, Apetalæ, and Gamopetalæ. The following are the more important general results:—

In a great majority of cases the dots are organs of secretion, which may be classified as follows:—

1. Resin- or Oil-glands. (*a*) Resin-cells cause transparent points in the Laurineæ, Monimiaceæ, Piperaceæ, a few Myrsineæ, Meliaceæ, Sapindaceæ, Canellaceæ, Anonaceæ, and Magnoliaceæ. (*b*) Resin-cavities give this appearance in *Salisburia*, the Myoporineæ, Myrsineæ, some Primulaceæ, Samydeæ, Myrtaceæ, some Leguminosæ, Rutaceæ, and Hypericineæ. A clear distinction between these two is not always so easy as might at first sight be supposed; a close connection may be established between resin-cells and lysigenous resin-cavities. The latter merely represent groups of cells which secrete resin internally; the former similar solitary cells. In the former the membranes of the secreting cells are finally absorbed, being only rarely permanent, as in *Myrospermum*, while in solitary resin-cells the persistence of the membrane is the rule, its absorption the exception. Schizogenous resin-cavities differ somewhat more decidedly from resin-glands. They resemble lysigenous resin-cavities in the grouping of secreting cells, but differ both from them and from the unicellular resin-glands in the secretion collecting outside the cells. In many families, as for example the Laurineæ, where there are internal glands, external glands are wanting.

The author considers the resins and volatile oils as true secretions. In some cases, as in Laurineæ and Piperaceæ, it is certain that the resin is made no further use of after its first excretion; and in no case was he able to detect any resorption of it. Volatile oils

* Flora, lxv. (1882) pp. 339–50, 355–68, 371–81, 387–97, 411–7.

and resins must be regarded as equivalent in function; they occur constantly intermixed, and a volatile oil frequently passes over into a resin from contact with the air.

2. Cells with mucilaginous membrane. (*a*) Mucilage-cells of the inner tissue of the leaf cause transparent dots in the Laurineæ and Anonaceæ. (*b*) Groups of epidermal cells with mucilaginous inner membrane give this appearance in *Stylogyne* (Myrsineæ), *Gnidia involucrata* (Daphnoideæ), and some Sapindaceæ. The mucilage is in these cases always derived from the cell-wall, which has become thickened at the expense of the cell-cavity. Its physiological function is at present uncertain.

3. Crystal-containing cells. (*a*) Cells with clusters of calcium oxalate appear as transparent dots in the leaves of some Euphorbiaceæ, the Alangieæ, Combretaceæ, some Meliaceæ, and some Rhamneæ; the latter containing also single crystals. (*b*) Cells with raphides of calcium oxalate cause transparent dots in the Dioscoreæ, Smilaceæ, *Decumaria* (Saxifragaceæ), Ampelideæ, Balsamineæ, and some Ternstroemiaceæ.

These deposits of calcium oxalate, which are often accompanied by mucilaginous substances, must also be regarded as secretions, although instances are known in which these crystals are resorbed.

Spicular cells also occur as transparent dots and streaks, as in *Moutabea* and *Gnetum*.

As regards the systematic value of transparent dots, this can only be taken into account if the term is used in a somewhat enlarged sense, to include not only visible dots, but such also as are concealed in the tissue, and can be made out only by section and under the Microscope. With this meaning of the term, the pressure of raphides-sacs in the leaves is constant in the Dioscoreæ, Smilaceæ, and Taccaceæ, although seldom producing visible transparent dots. The leaves of the Laurineæ are always abundantly perforated either with mucilage- or resin-cells, or with both. The occurrence of cells with mucilaginous membrane in the interior of the leaf has been observed only in the Laurineæ and Anonaceæ. Oil- or resin-cells are constant in the Piperaceæ and Monimiaceæ; from the latter order they are never absent; in the former their detection failed only in three species of *Piper*. Internal glands with brown radiately crystalline resin are characteristic of the Myrsineæ, and but rarely wanting in them; they are less common in the Primulaceæ. In the Myrtaceæ the presence of oil-cavities is characteristic of three of the suborders (Chamælaucieæ, Leptospermeæ, and Myrteæ), while they are absent from the other two (Barringtonieæ and Lecythideæ).

Epinasty of Leaves.*—E. Mer finds that the epinasty of leaves, that is, the tendency of leaves to bend downwards owing to the more rapid growth of the upper surface—is attributable to the following conditions:—(1) It is the result of the development of the palisade-cells of the leaf from the influence of light. (2) Transpiration is not necessary to its development. (3) Neither is assimilation nor the

* Comptes Rendus, xcv. (1882) pp. 1239–42.

production of chlorophyll necessary to this result. These latter conditions, however, though not indispensable, indirectly favour epinasty by promoting the development of the palisade-cells.

Starch-generators and Pigment-bodies.*—A. F. W. Schimper applies the general term *Plastid* to the solid bodies, chlorophyll-bodies, starch-generators, and pigment-bodies, designating them respectively *Chloroplastids*, *Leucoplastids*, and *Chromoplastids*. Chloroplastids are always formed from leucoplastids, by increase of size combined with development of the pigment; chromoplastids always from leucoplastids and chloroplastids. The plastids frequently have an active life, assimilating or producing starch at the expense of already assimilated materials, multiply by division, &c. But others have either very little vital function or none at all, as in the case of the leucoplastids in the epidermis of most plants, and the chromoplastids of flowers and fruits, and of the carrot. These passive plastids have very often a more or less completely crystalline form, and are doubly refractive. The active plastids are always round in the higher plants.

Many of these passive plastids have in fact been described as crystals, as those of the carrot and of *Neottia nidus-avis*. In the carrot they are usually rectangular plates or narrow rhombs, to which starch-grains are attached. In form and optical properties they agree with crystals of the rhombic system. The brown chromoplastids of *Neottia* are also often of regular rhombic or triangular form, and also usually have starch-grains attached to them. In other flowers and fruits are two- or three-pointed plates, the former oval, fusiform, or acicular; less often the chromoplastids are rod-shaped and rounded at the ends. But the plastids have sometimes less regular crystalline forms, as those of the carrot and *Neottia*, but still are distinctly crystals, and doubly refractive. In some flowers, like those of *Tropæolum* and *Echeveria*, the chromoplastids are much less regular and crystalline, and in *Asphodeline* have even a rounded outline with indications of two or three edges. In *Iris Pseudacorus* the plastids are disk-shaped or irregular, or of a rounded triangular form. In other flowers and fruits the plastids are quite round.

The leucoplastids are sometimes also doubly refractive, and vary in form between flatly fusiform and rod-shaped. Regularly fusiform chloroplastids occur in the epidermis of leaves, where, at an early stage, they are colourless. These crystalline leucoplastids agree in everything except colour with chromoplastids, and sometimes become directly transformed into them.

Although these plastids would be determined by the crystallograph to be crystals, yet they differ from true crystals in some important points. They are composed, at least sometimes, of vital protoplasm, although it may sometimes be dormant or nearly so. Under certain conditions, they have the power of entering again into vital activity, losing more or less of their form. Sometimes they generate in their interior large quantities of starch, and become more or less rounded, or under the influence of light they become transformed into chloroplastids.

* Bot. Centralbl., xii. (1882) pp. 175–8.

The development of crystalline plastids resembles in general terms that of true crystals, especially the freezing of a drop of water, but is much slower in fully developing. The author believes that this is due to a true process of crystallization, and that plastids are examples —the only ones at present known—of crystals composed of vitally active protoplasm.

In a paper on the same subject, A. Meyer * proposes a somewhat different terminology. To the minute bodies termed plastids by Schimper, from which chlorophyll-grains, pigment-bodies, or colourless substances are eventually developed, he applies the term *Anaplasts*. The starch-generators are anaplasts in which starch-grains are developed. The pigment-bodies he proposes to call *Chromoplasts*, the chlorophyll-grains *Autoplasts*. And since anaplasts, chromoplasts, and autoplasts are all nearly related in structure and origin, he includes them in the common term *Trophoplasts*.

In angiosperms the multiplication of trophoplasts appears always to take place by division. This is especially the case with autoplasts, which are never formed directly out of protoplasm. It would appear that every living cell must contain trophoplasts, which have been found in sieve-tubes and in sclerenchymatous, parenchymatous, and epidermal cells. No resorption of the trophoplasts ever takes place; they develope into anaplasts, chromoplasts, or autoplasts. They perish only when the cell itself dies.

Honey-glands of Cruciferæ.†—J. Velenovsky does not agree with the proposal to use the position of the honey-glands in Cruciferæ as a primary character for the classification of the genera. It is, however, of secondary use, since the form of the honey-glands corresponds not only with the form and nature of the fruit, but also with the habits of the plant. It corresponds also with the form and structure of the flower, since the honey-glands are emergences from the receptacle, and are entirely dependent on the form, size, and structure of the parts of the flower. Their development depends especially on the suppression or otherwise of any of the stamens; those connected with the shorter stamens are always present. The author found no species from which honey-glands are entirely absent.

Organs intermediate between Root and Leaves.‡—D. Clos proposes the term "phyllorhize" for organs intermediate between root and stem, which cannot be brought under any morphological scheme, such as the finely divided so-called "leaves" of many water-plants. They pass over into true leaves either suddenly, as in *Trapa*, *Salvinia*, and *Azolla*, or gradually, as in *Limnophila*, *Myriophyllum*, and *Elatine*. The submerged vegetative parts of *Utricularia* combine the characters of root, stem, and leaf. The pitchers of *Utricularia*, *Nepenthes*, *Cephalotus*, and *Dischidia* are not, according to the author, metamorphosed leaves or hairs, but independent morphological structures.

* Bot. Centralbl., xii. (1882) pp. 314–7.

† On the Honey-glands in Cruciferæ (in Magyar); Prague, 1882. See Bot. Centralbl., xii. (1882) p. 264.

‡ Mém. Acad. Sci. Toulouse, 1882 (1 pl.). See Bot. Centralbl., xii. (1882) p. 293.

Sieve-Tubes.*—Continuing his investigation of sieve-tubes, E. de Janczewski has now made an exhaustive comparison of their structure in the different primary sections of the vegetable kingdom, with the following general results:—

The elements of sieve-tubes are always prismatic in form, more or less elongated, and truncated transversely or obliquely. Their walls are composed of pure cellulose, and are never lignified; they always have a larger or smaller number of pores, which either permanently retain this structure (in vascular cryptogams), or soon become perforated and transformed into true sieves (phanerogams). The mature elements are sometimes empty (gymnosperms), sometimes they contain a parietal layer of granular protoplasm (vascular cryptogams and angiosperms); the nucleus is always wanting.

In vascular cryptogams the elements of the sieve-tubes are no longer than those of the parenchymatous tissue. They contain proteinaceous globules adhering to the parietal protoplasm, and collected below the pores. The lateral and terminal walls are furnished with a larger or smaller number of pores. The membrane of these pores is never perforated, and presents an obstacle to the intercommunication of the contents of adjoining elements; it is generally homogeneous, and composed simply of cellulose; it is sometimes pierced by callose cylinders (as in *Pteris aquilina*). The sieve-tubes are not influenced by the time of year, but maintain the same condition during their whole existence.

In gymnosperms the life of the sieve-tubes may be divided into two epochs, evolutive and passive. During the first period the pores situated in the walls of the young tubes produce callose substance, and are transformed into sieves covered and closed by callus; at this period the elements of the tubes contain parietal protoplasm, and resemble those of vascular cryptogams. During the second period the tubes are totally destitute of protoplasm, and are consequently inert; but there is a communication between adjacent tubes, the sieves losing their callus towards the close of the evolutive period.

In dicotyledons the structure is more complicated, and the life of the sieve-tubes may be divided into four periods:—evolutive, active, transitory, and passive. During the first period the cambial cell is not transformed directly into an element of the sieve-tube, as in gymnosperms; it always divides longitudinally, and produces on one side an element of the sieve-tube, on the other side a mother-cell of the liber-parenchyma, or companion-cells, usually two in number. In the elements thus formed the pores of the walls or the whole of the horizontal septa are covered with a callose substance, and become perforated into true sieves composed of a delicate network of cellulose and a callose envelope. From this moment the sieve-tubes have entered their active period, characterized by the sieve-structure, and by the intercommunication of the protoplasmic contents of adjacent elements. This period sometimes lasts for months or years. In some cases (*Aristolochia Sipho*, *Fagus*, *Tilia*, *Rosa*) the sieve-tubes in

* Ann. Sci. Nat., xiv. (1882) (6 pls.). Cf. this Journal, ii. (1882) p. 370.

this condition are not affected by changes of season; in others (*Vitis*, *Tecoma*) the sieves close up before winter, and open again in the spring, from the swelling and contraction of the callose substance which covers them. During the whole of the active period the tubes contain protoplasm, a larger or smaller quantity of a proteinaceous mucilaginous substance (as in *Tilia*, *Vitis*, *Fagus*, &c.), and sometimes starch (*Vitis*, *Tecoma*, *Fagus*). The transitory period usually lasts only for a short time, and is independent of the time of year; in *Vitis* and *Pyrus* it commences in the autumn. During this period the elements of the sieve-tubes gradually lose their contents; the sieves, previously closed by callus, again open, from the complete absorption of this substance. They have now entered the passive period, are destitute of all organized contents, and totally inert; the sieves being reduced to a delicate network of cellulose.

In monocotyledons the development and behaviour of the sieve-tubes is precisely the same as in dicotyledons; their existence may be divided into four periods. The fibrovascular bundles are, however, closed, having no cambium-zone capable of producing new sieve-tubes to replace those that have become passive. The active period, therefore, lasts, as in vascular cryptogams, so long as the life of the organ requires them. The passive period is, in fact, manifested only in very old rhizomes, as in *Phragmites*. In our climate the active tubes possess, like those of *Vitis*, the power of closing the sieves in autumn and opening them again in spring. The elements of the active sieve-tubes contain no starch nor any mucilaginous substance; nor does their parietal protoplasm contain any proteinaceous globules, which appear to be absorbed in spring, and to contribute to the density and refrangibility of the protoplasm.

Sieve-tubes have, therefore, not the same structure in all vascular plants; it becomes more and more complicated, more and more characteristic, and more and more adapted to fulfil a physiological function, with the elevation of the plant in the scale of organized beings.

Adventitious Roots of Monocotyledons.*—A careful study made by L. Mangin of the origin and insertion of the adventitious roots of monocotyledons has led to the following results:—

In all monocotyledons the adventitious roots originate, in accordance with the constitution of the tissues of the stem, in a special meristem formed from the peripheral layer of the central body. The central body and the cortex of the young root only appear to be formed from this meristem; its cap is derived from the internal layers of the cortex. This meristem, which the author calls the *dictyogenous layer*, developes also a special system of fibrovascular bundles intermediate between the root and the stem. This system varies in its arrangements in different groups of monocotyledons.

In the first and largest group, with annual or perennial, aerial or underground stem, these bundles constitute a network which always occupies the periphery of the central body, the *radiciferous network*.

* Ann. Sci. Nat., xiv. (1882) pp. 216–363 (8 pls.).

It is sometimes developed through the whole extent of the stem (*Ruscus*, *Acorus*); sometimes it occurs only at the nodes (*Convallaria*); sometimes it is found at the base of the stem (*Antholyza*, *Asphodelus*, *Crocus*). This network is in connection, on one hand, with the lower termination of the common bundles; on the other hand, with the vascular and liber-plates of the root. In a second group of monocotyledons, those with a variable growth in thickness, the dictyogenous layer, instead of losing its activity immediately after the development of the roots, as in the first class, preserves its activity for a time. The dictyogenous layer then sometimes (*Aloë*) developes several plates of anastomosing bundles, on which the adventitious roots are inserted at varying depths; its activity then extends as far as the protective sheath or endoderm. Sometimes (*Agave*) the dictyogenous layer retains its active condition through the whole life of the plant, and incites the formation of a great mass of fibrovascular bundles, thus favouring the formation of a large number of adventitious roots. In *Dracæna* and *Yucca* the dictyogenous layer is replaced by a secondary meristem which determines the formation of the bundles without relation to the leaves; on these are inserted the adventitious roots. The structure of the Pandanaceæ and Palmæ prevents the formation of this radiciferous network; in these plants the dictyogenous layer organizes the roots; the fibrovascular bundles penetrate more or less deeply into the central body, and meet the common bundles.

Two kinds of stem may be distinguished in monocotyledons, those with and those without roots. The latter, supporting the organs of reproduction, and often the leaves, never possess the power of growth in thickness. Their structure is very constant, and is characterized by the existence, at the boundary of the cortex and central body, of an external sheath formed by the lignification of the external layers of the central body, and forming the chief organ for support in the stem. Stems provided with roots are very variable in their structure, and are characterized by the existence of a dictyogenous layer, and by the presence of the endoderm formed from the internal cortical layer. They may increase in thickness temporarily (*Aloë*, *Apicia*), or permanently (*Yucca*, *Dracæna*); but the stems of most monocotyledons (Pandanaceæ, some Palmæ, Liliaceæ, Irideæ, &c.) have no such power. The generating zone or ring of growth described by some anatomists, is only the dictyogenous layer, the function of which is to develope the roots and the fibrovascular system which connects the root with the stem.

Generation of Heat by Arum italicum.*—G. Kraus has tested the elevation of temperature which accompanies the unfolding of the spathe and the opening of the flowers of *Arum italicum*, and found that where a thermometer was placed in the midst of five opening spathes it rose from 17°·7 to 44°·7 C. The heating commences at the apex of the spadix, where it is most considerable, and proceeds down-

* Abhandl. Naturforsch. Ges. Halle, xvi. (1882) (2 pls.). See Bot. Centralbl., xii. (1882) p. 224.

wards; the elevation of temperature of the anthers takes place much later, and is less considerable; the female flowers experience none at all. The stigmas are mature considerably before the anthers, and the object of the phenomenon is evidently the attraction of insects to assist in cross-fertilization; it disappears as soon as its purpose is accomplished; and the insects are imprisoned by an arrangement of hairs until the anthers discharge their pollen.

Formic and Acetic Acids in Plants.*—Dr. Bergmann sums up the results of his investigations as to the occurrence and import of formic and acetic acids in plants as follows:—(1) Formic and acetic acids are met with as constituents of protoplasm throughout the whole of the vegetable kingdom in the most various portions of the plant-organism, and both in chlorophyllaceous and non-chlorophyllaceous forms. (2) Formic and acetic acids are to be regarded as constant products of metastasis in vegetable protoplasm. (3) It is probable that other members also of the unstable group of fatty acids, as for instance, propionic acid, butyric acid, caproic acid, or even the whole group, are universally distributed in the vegetable kingdom. (4) An increase of the amount of unstable acids takes place in a plant-organism when its assimilation is interfered with by deprivation of light, i.e. when put into a state of starvation (inanition). (5) Formic and acetic acids accordingly belong to the constituents of retrogressive tissue-metamorphosis. It has been premised that the homologous unstable fatty acids have a similar import in vegetable tissue-metamorphosis. (6) No increase in the amount of unstable acids takes place in a plant-organism which is withdrawn for a period from the light, under the minimum-temperature required for growth. (7) Accordingly the formation of formic and acetic acids in a plant seems to take place to a certain degree independently of respiration. (8) Acetic and formic acids are mainly to be regarded as decomposition products of the constituents of vegetable protoplasm.

Fertilization of Flowers by Insects.†—H. Müller continues a detailed report of observations on this subject, supplementary to his work 'Die Befruchtung der Blumen durch Insekten,' and defends the above title from strictures brought against it by Behrens and others.

Influence of the Electric Light on the Development of Plants.‡—P. P. Déhérain's experiments were made at the Palais d'Industrie during the Paris Electrical Exhibition of August 1881. A greenhouse was divided into two compartments, one glazed with blackened perfectly opaque glass, whilst the other was exposed to the ordinary diffused daylight of the Exhibition building. The darkened chamber was illuminated continuously, night and day, by a 2000 candle arc-light from a Gramme machine. The transparent

* Bot. Ztg., xl. (1882).

† Verhandl. naturhistor. Ver. preuss. Rheinlande u. Westfalens, xxxix. (1882) pp. 1–104 (1 pl.).

‡ Ann. Agronomiques, vii. (1882) pp. 551–75. See Journ. Chem. Soc. Abstr., xliv. (1883) pp. 105–7.

chamber was illuminated at night only by the electric light. Five series of comparative observations were made, viz.:—

1. Plants exposed night and day to the electric light alone.

2. Plants exposed during the day to the diffused daylight, and during the night to the electric light.

3. Plants living during the day in the open air, and receiving the electric illumination at night.

4. Plants passing the day in the diffuse daylight, and the night in darkness.

5. Plants living normally in a garden.

The plants submitted to experiment were barley, flax, beans, and a number of garden and greenhouse plants.

Action of the Unprotected Light.—At the end of seven days the naked electric light was seen to have an injurious effect both on those plants which were constantly subjected to it, and in a less degree on those which were exposed to it during the night only. The leaves blackened, withered, and dropped off; the injury was confined to the epidermal layers, and was due to the direct impact of the luminous radiations (and not to the formation of nitrogen oxides); for where one leaf was partly shaded by another, a sharp line was photographically impressed.

Experiments on *Elodea canadensis*, submerged in flasks of water, showed that while the diffuse daylight of the building was unable to cause decomposition of carbonic anhydride and evolution of oxygen, the direct rays of the electric light were able to do so, about as much oxygen being obtained during an exposure of four or five days and nights to the electric light as could be obtained in an hour or so in bright sunlight. At the end of fifteen days the arc-lights were inclosed in globes of transparent glass, Siemens' just published experiments having shown that the injurious action of the direct radiations was thereby modified.

Action of the Protected Light.—A number of fresh and uninjured plants were placed in the greenhouse, and in addition sowings of barley, oats, peas, maize, beans, which had just appeared above the ground. All the seedlings exposed exclusively to the electric light perished sooner or later, and the leaves of some of them were blackened as with the naked light. The mature plants, on the other hand, continued to vegetate, but in no case, save a plant of barley, were flowers and seeds produced, the vegetation being purely foliaceous. The barley grains were normal, and germinated on being sown. The electric light employed was clearly insufficient by itself to determine the assimilation of any considerable quantity of material; direct experiments also proved that it is not more powerful in exciting transpiration of water, a leaf exposed to it giving off in an hour only about one-fiftieth of the quantity of water evaporated under similar circumstances in sunlight. As the evaporation of water by the leaves is one of the chief agencies in causing the migration of material necessary for the maturation of seeds, the failure of the plants to produce flowers and seeds receives its explanation. It is known that yellow and red rays are most powerful in causing transpiration, whilst

the electric light is particularly rich in blue and violet rays. The author considers the electric light employed as too feeble to allow of any conclusion as to the necessity of a nocturnal rest to plants. It was, however, evident that the electric illumination during the night was advantageous to those plants which passed the day in the rather feeble diffuse daylight of the palace. In a third series of experiments, the intensity of the electric light was practically augmented by placing the plants nearer the lamp. The experiment was again fatal to young seedlings receiving the electric light exclusively, but many of the hardier and more mature plants survived, although the leaves of some were blackened by their too great proximity to the light; and again the nocturnal electric illumination was decidedly favourable to the plants which passed the day in the light of the palace. The author sums up his conclusions thus:—

1. The electric arc-light emits radiations which are injurious to vegetation.
2. Most of these radiations are arrested by colourless glass.
3. The electric light emits radiation powerful enough to maintain mature plants in vegetation for two months and a half.
4. The beneficial radiations are not sufficiently powerful to cause the growth of germinating seeds, or to allow of the maturation of fruit in older plants.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Peculiar Form of Stereome in Ferns.*—E. Giltay describes a peculiar form of sclerenchymatous cells in *Aspidium* (*Polystichum*) *Berteroanum*, occurring free in the rhizome in the fundamental tissue, and usually hardened on one side only. These cells were in contact with one another by their thickened sides, the unthickened sides being in contact with the surrounding thin-walled parenchymatous cells. Continuous hard ridges are thus formed in the fundamental tissue, which must contribute considerably to the firmness of the organ. This hardened tissue is usually found near the fibrovascular bundles, often reaching to the endoderm, and appears to perform the function of a protecting sheath.

These half-sclerenchymatous half-parenchymatous cells are filled with starch like the surrounding thin-walled cells; they were usually of large size. Occasionally a few that were associated with them were completely sclerenchymatous.

Of a large number of species of ferns examined, only the one already named and *Aspidium* (*Polystichum*) *Richardi* contained these half-sclerenchymatous cells; in all the other species they were either entirely wanting or only faintly indicated.

Structure and Branching of Dorsiventral Polypodiaceæ.†—According to L. Klein, in *Polypodium Heracleum* and *quercifolium*,

* Bot. Ztg., xl. (1882) pp. 694–7 (1 pl.).

† Klein, L., 'Bau u. Verzweigung einiger dorsiventral gebauten Polypodiaceen.' Halle, 1881, 64 pp.

the leaves stand in a single dorsal row on the mature stem, while younger plants and weaker lateral branches have their leaves in two rows. The very complicated vascular-bundle system of the stem consists of a number of anastomosing bundles which constitute, in the mature plant, two concentric sheaths, from the outer of which spring the root-bundles, from the inner the leaf-bundles. The bundle-system of weaker shoots is a simpler form of the same structure. In *Polypodium tæniosum* the leaves are arranged in several dorsal rows, with more or less evident parastichies.

In all the Polypodiaceæ examined, those with the leaves in a single row, like *P. tæniosum*, as well as in many with the leaves in two dorsal rows, *P. vulgare*, *aureum*, *Phymatodes*, *ireoides*, &c., the leaves originate in the growing point in the same arrangement as they exhibit when mature; and no displacement takes place, as is sometimes described.

North American Isoetes.* — G. Engelmann describes in detail the North American species of *Isoëtes*. Only one species, *I. cubana*, belongs to the section with three-lobed stem; all the rest, including one new species, *I. Howellii*, have the stem two-lobed, like our *I. lacustris*. These he divides into three sections:—(1) Submerged species, with tetragonous leaves, almost always without stomata; without peripheral sclerenchymatous bundle; velum more or less imperfect. (2) Amphibious species, with tetragonous leaves and numerous stomata. (3) Terrestrial species, with numerous stomata, and peripheral sclerenchymatous bundles in the nearly trigonous leaves.

Fungi.

Spermogonia of Uredineæ and their Relation to Insects.† — E. Ráthay has examined the structure of the spermogonia of a number of Uredineæ, in relation to the visits paid to them by insects, attracted by their bright colour, sweet taste, and frequent odour. In all the 21 species examined, the spermogonia, whether tasteless or more or less intensely sweet, were found to contain a sugar capable of reducing Fehling's solution, believed by the author to be arabinose. In 14 kinds he made direct observation that the contents of the emptied spermogonia attract insects, of which as many as 135 distinct species were seen to visit them.

The spermogonia excrete the saccharine fluid not only during rain, but even when the air is dry; this Ráthay considers to be effected, as in the nectaries of flowering plants, by osmotic action; the gelatinous fluid carrying the spermatia with it. As long as the nature of the spermatia is not fully understood, the object of this contrivance for attracting insects must remain unexplained; the author believes them to be sexual organs with a male function.

* Trans. St. Louis Acad. Sci., iv. (1882) pp. 358–90. See Bot. Centralbl., xii. (1882) p. 290.

† Denkschrift der K. Akad. Wiss. Wien, xlvi. (1882). See Bot. Ztg., xl. (1882) p. 906.

Reproductive Organs of Ascomycetes.*—C. Fisch has made a careful examination of the structure and development of the perithecia, asci, and other reproductive organs of the following fungi:—*Polystigma rubrum* and *fulvum*, *Xylaria polymorpha*, *Claviceps purpurea*, and *Cordiceps ophioglossoides*, *militaris*, and *capitata*. The following are the general results at which he has arrived.

In the two species of *Polystigma*, the author has no doubt that in the ascogonium with its trichogyne-threads on one hand, and in the spermogonium on the other hand with its abstriction of spermatia, we have sexual organs. The degeneration of the trichogyne, however, takes place in a somewhat different way from that described by Stahl in the case of *Collema*. But at present we have no direct evidence of any actual act of conjugation in the case of *Polystigma*.

In *Xylaria* the asci are unquestionably formed in the perithecia without the operation of any sexual organs; they are purely vegetative offshoots. This process is always preceded by the formation of Woronin's hyphæ, which appear at first sight to have some analogy with the scolecite of *Ascobolus*; but in *Xylaria* these certainly have no sexual function.

In *Claviceps* and *Cordiceps* the complete disappearance of the rudimentary and functionless ascogonium indicates the last stage to complete apogamy. *Claviceps* does not show the least trace of sexual organs; the asci are formed within the perithecium by a true vegetative process. But this genus differs from all other stroma-forming Pyrenomycetes that were examined, by a formation of true tissue in the construction of the asci, analogous to that described by Bauke in *Pleospora*.

The Pyrenomycetes may be regarded as forming a series, the highest forms of which exhibit a complete differentiation of sexual organs, ascogonium, trichogyne, and spermatia; while the lowest forms are strictly apogamous. The function of the conidia, which also occur in some simple Pyrenomycetes and Discomycetes, and which are often confounded with spermatia, must still remain in doubt.

Fecundation of Achlya and Saprolegnia.†—N. Pringsheim claims to have detected the mode in which the actual fecundation of the oospheres of *Achlya* and *Saprolegnia* takes place. The fertilizing tubes are stated by de Bary to remain always closed, and not actually to coalesce in their growth with the oospheres. Pringsheim states, however, that an intimate coalescence between the two does take place. In the protoplasm of the antheridia and fertilizing tubes are peculiar protoplasmic bodies distinguished by their greater refrangibility; they are larger than the fusiform nucleus, and exhibit extremely slow and sluggish amœboid movements. They closely resemble the spermatozoids of *Monoblepharis* described by Cornu, and are called by Pringsheim *spermamœbœ*. They eventually

* Bot. Ztg., xl. (1882) pp. 851–70; 875–97; 899–906 (2 pls.).

†[SB. K. Akad. Wiss. Berlin, 1882, pp. 855–88. See Bot. Centralbl., xii. (1882) p. 322.

reach either the apex of the fertilizing tube or a short lateral protuberance; the whole of the protoplasm contained in the apex of the tube or in this protuberance then forces its way through the wall, without any actual orifice being perceptible in it. In the union of these with the protoplasm of the oosphere he believes the act of fecundation to consist. That these bodies are not parasites is shown by the fact that they exhibit no trace of further development after reaching the oosphere; that they are found in no other part of the *Achlya*; and that the time of their appearance always coincides with that of the maturity of the oosphere. When formed in tubes which do not come into contact with an oogonium, they always perish without exhibiting any indication of independent life.

A. de Bary in reply,* admits the correctness of Pringsheim's statement with regard to the entrance of these bodies into the oogonium, which, indeed, he had himself previously described. But he does not consider that there is at present any direct evidence that they have any fertilizing function. Nor does this in any way explain the phenomenon of parthenogenesis in *Achlya*, where fertilization takes place without the presence of antheridia. De Bary supplements his paper with diagnoses of the seven known species of *Saprolegnia*.

W. Zopf contends † that the alleged "spermamœbæ" of Pringsheim are nothing but parasites, the occurrence of which in the described situations in *Achlya* and *Saprolegnia* has long been known.

Morphology and Development of the Perithecium of Meliola.‡—H. Marshall Ward gives an abstract of his investigations of this epiphytic fungus. The much branched mycelium consists of jointed cylindrical hyphæ, with hardened brown or black cell-walls, and finely granular protoplasmic contents; these are closely attached to the epidermis of tropical plants by rudimentary *haustoria*, which are closely adherent to the cuticle, but do not pierce the cells of their host.

Attached to and developed from the mycelium are setæ, which appear to have no special function, and are, at any rate, not tubes for the passage of the spores. Other appendages develope new mycelia by budding, and others give rise to the perithecia, which are more or less globular cases containing asci in their interior. Especial attention has been directed to these organs, and the "core" or contained thin-walled cells is stated to be an ascogonium. The asci themselves are delicate clavate sacs, containing two to eight spores; each spore developes a rudimentary haustorium, and gives rise to a mycelium. The Meliolas appear to form a group, allied to the Erysipheæ, &c., but in which the sexual process is still more suppressed. The injury caused by these fungi appears to be due to their depriving the leaves of light and air, and blocking up the stomata.

* Bot. Ztg., xli. (1883) pp. 38–46, 54–60.
† Bot. Centralbl., xii. (1882) pp. 356–7.
‡ Proc. Roy. Soc., xxxiv. (1882–3) pp. 388–90.

Selenosporium aquæductum.*—B. Eyferth describes a peculiar fungus which he found on mill-wheels in the neighbourhood of Brunswick, especially in the late autumn and beginning of winter, and which he identifies with *Selenosporium aquæductum*, discovered in 1862–3 in Munich by Radlkofer, but not observed since.

The small cushions composed of this fungus are firmly attached to their support, and unite into a layer some millimetres in height, composed in the lower part of matted horizontal threads, from which a number of nearly parallel branches rise. On short pedicel-like branches of these are formed the conidia, which are normally fusiform and somewhat sickle-shaped at the apex, are usually divided by several septa, and readily fall off, often before they attain their normal form. They can readily be mistaken for *Torula*, and especially for *Mycoderma*, and are capable of germination even in this imperfect condition. The fungus is present during the whole year, but thrives best in autumn and winter. It is destroyed by severe frost. It exhales a characteristic intense aromatic odour.

The author was unable to detect that the presence of this fungus is due to the sugar-factories on the stream. At a part of the stream where there are none, but where the water contains a large quantity of lime, it occurs also, living saprophytically on the dead cells of algæ. From the endophytic bundles of threads found inside these, the fungus developed in the form of somewhat knotty hyphæ, resembling the aquatic mycelium of *Mucor racemosus*, but not forming gemmæ. The filaments become afterwards more slender, and develope the sickle-shaped conidia only at the margin where exposed to the air. The fungus indeed requires for its development free access of air, and soon perishes under water. The best nutrient fluid is a solution of cigar-ash and grape-sugar (1–2 per cent. of each).

Hypholoma fasciculare, an enemy to forest-trees.†—F. Ludwig describes the destructive effect of the mycelium of this fungus on the roots of pine trees. The bark was partially split, and the leaves had dropped off except a single terminal tuft. The lower part of the trunk was covered with great quantities of the fructification of the same fungus.

Paipalopsis Irmischiæ.‡—J. Kühn describes under this name a fungus, which he regards as a new generic type of Ustilagineæ, parasitic on species of *Primula*, especially *P. officinalis* and *elatior*. It attacks principally the stamens, but is found also in the corolla and ovary, reducing the internal tissue to the condition of a fine powder. Its spores increase by division and lateral budding, thus forming balls or strings composed of a number of spores separated from one another by gelatinous layers. The mycelium penetrates the tissue of the host, the spores being found at the projecting and exposed apices of some of the hyphæ.

* Bot. Ztg., xl. (1882) pp. 691–4 (1 pl.).

† SB. Ges. naturf. Freunde zu Berlin, Oct. 17, 1882. See Bot. Centralbl., xii. (1882) p. 318.

‡ Irmischia, ii. (1882) pp. 39–40. See Bot. Centralbl., xiii. (1883) p. 1.

Pathogenous Mould-Fungi.* —Whilst occupied with his researches into the result of ureter ligature, L. Lichtheim constantly found that in the kidneys whose ureter was bound filamentous fungi appeared, in most cases limited to the renal basin, but in one instance growing within the kidneys themselves and spreading fan-like from the papillæ towards the edge. The author's chief object was to determine whether, in the cases under consideration, the fungus was an accidental importation which had adapted itself to the conditions of the body, or whether he had to deal with some † peculiar and separate species.

In repeating Grawitz's experiments, he found that *Penicillium* was innocuous, while *Aspergillus* retained its virulence a longer time when its culture was carried on at the temperature of a room; it even developed spontaneously when grown in the same temperature. After these results the only thing possible for him was to assume that the virulence obtained by Grawitz by propagation at the temperature of the human body must have been the consequence of a constant impurity of his cultures. The intermediate forms which presumably belonged neither to *Aspergillus* nor to *Penicillium*, were possibly *Oidium lactis*. But the writer did not rest here, more especially since Grawitz in his reply decidedly asserted that the patches whose spores were injected were *Aspergillus*. This contradiction was however explained when he discovered green *Aspergillus*-forms in which the pathogenous qualities were wanting. These were distinguished from the malignant *Aspergillus* by the size and shape of the sporangiophore, as well as the size of the spores. The mycelium was stouter, the spores were about 14 μ wide, the sporangia were larger but less regular, and formed only slight club-like protuberances, and the sterigmata were often of considerable length. While the *Aspergillus* hitherto experimented on exhibited strongly refringent thin-walled conidia very like the *Penicillium*-spores, those of the new fungus were often oval, somewhat thicker-walled, and much larger, the mean measurement of the former being 2·5–3 μ, that of the latter 10–12 μ. After repeated propagations, both still exhibited the same characteristics. There was however a considerable variation in the conditions of growth. Although the larger did not grow more quickly at the ordinary temperature of a room than the smaller, yet it could not be induced to germinate on moist bread, potatoes, and the like substances in the breeding-stove. Somewhat later was discovered, in quinces preserved with sugar, a new but not injurious form. The very large green sporangia are in these less crowded together than in the pathogenous form. They have an extraordinarily broad sporangiophore, large sporangia of very regular form, and strong flask-shaped sterigmata. The conidia were round, very large (12–13 μ when mature), and distinguished by an extraordinarily thick yellowish envelope which had a distinctly warty thorn-apple like surface. From those kept in a warm atmosphere nothing came; those growing in the cold produced after six days the first conidia,

* Berliner Klinische Wochenschr., 1882, pp. 129, 147. See Bot. Centralbl., xi. (1882) pp. 65–8.

† See this Journal, i. (1881) p. 278.

and developed a fungus like that which had been sown. The original green colour of this culture became later yellow, then reddish-yellow, and at last red, and now contained abundant bright yellow perithecia. De Bary determined this fungus to be the typical *Aspergillus glaucus*, the *Eurotium* (*Aspergillus*) *glaucum* of de Bary. Respecting the earlier mentioned larger but also non-pathogenous form, he is doubtful whether it is a distinct species or only a variety of the ordinary *Aspergillus glaucus*. Further examination of the smaller pathogenous form led the author at last to this conclusion, that it is identical with *Aspergillus fumigatus* Fres., which is more often found in the tracheæ of men. That the genuine *Aspergillus glaucus* can be pathogenous in the tracheæ of birds, while to rabbits it proves innocuous, is not to be denied. It is indeed certain that mould-fungi, like Schizomycetes, affect different species of animals in entirely different ways. Earlier observers were as little able as Grawitz to produce pathogenous effects in rabbits; the writer was therefore led to assume that they had worked with *Aspergillus fumigatus*. In the experiments of Grawitz this explanation was all the more plausible, as no exact description was given by him of the fungi employed, and it is difficult to distinguish the green patches of the latter from *Penicillium*. Lichtheim concludes without hesitation that the results of Gaffky must also have been obtained from *Aspergillus glaucus*. It became evident, however, that he and Gaffky had arrived at the same results with different fungi. Gaffky's fungus was not *Aspergillus fumigatus*. This fungus was yellowish-green, and therefore easy to distinguish from *Penicillium*. The conidiophores, sporangia, and sterigmata were more than double as large as in *Aspergillus fumigatus*. The sterigmata were conical or flask-shaped, like those of *A. glaucus*, the spores were also considerably larger than those of *A. fumigatus* (6–7 μ), faintly shining, and of a clear yellow, while the envelope was thin and covered with delicate wart-like excrescences. Perithecia were not observed, and when old the culture assumed a yellowish brown colour. Dr. Eidam has pronounced the fungus to be *Aspergillus flavescens*, a form which has likewise been observed to be a parasite in the ear.

The main results of the author's communications are these:— Up to the present time he has discovered two pathogenous forms amongst *Aspergilli*, one yellowish (*A. flavescens*), and the other greenish (*A. fumigatus*), both of which were already known as parasites. The pathogenous *Aspergilli* are, however, probably not yet exhausted; there must be yet one more pathogenous form with blackish patches which attacks mankind. All the mould-fungi observed by him, including the pathogenous, are species which retain both their morphological and physiological properties. Further, there are fungi which flourish most luxuriantly in alkaline fluids and at a high temperature, but which are not pathogenous. Finally, amongst the mould-fungi, as amongst the Schizomycetes, certain kinds are pathogenous to one animal which are harmless to another. Unequivocal proofs of this fact are yielded in the treatment by Lichtheim of other genera of mould, belonging to the *Mucorini*, the diseases caused by which will be considered in another article.

Organisms in the Mould of Beer.*—E. C. Hansen's continued experiments on this subject are characterized, as before, by the use of a single nutrient fluid, viz. sterilized wort. As before, test-tubes were employed, which during the ebullition of the wort were bound round with gauze and filter-paper; vacuum-retorts were also used and closed while the nutrient fluid was boiling, and allowed to stand until, judging from previous experience, no new forms were likely to develope.

As before it was proved that the air in many neighbouring places may contain, not only a varying number of organisms, but also distinct kinds. The experiments with the vacuum-retorts show that the micro-organisms of the air may appear partly in groups and clouds, with intermediate spaces entirely free from germs, and partially scattered singly in the atmosphere. The seasons of the year exercise a decided influence; but this, being complicated by other factors, is not always evident. The source of micro-organisms is easily recognized through working out a large number of analyses. Researches into the appearance of the species of *Saccharomyces* in the air of the garden show this clearly. Thus these yeast-fungi were found in abundance in the air under cherry trees from the beginning of July to the end of August in 1879, and to the end of September in 1880, but on the other hand none or very few appeared under vines. In accordance with this, we find that the cherries were ripe at the period named, but the grapes were not. In the season of 1879 fruit was more abundant in the gardens experimented on than in that of 1880, and there was a richer harvest of *Saccharomyces* in the former year than in the latter. The fruit season, August and September, was also the period in which these fungi were most abundant in the air. Experiments have proved that *Saccharomyces Cerevisiæ*, *pastorianus*, and *ellipsoideus*, can live through the winter in the earth, and there is much evidence that these species pass through a similar cycle of changes in nature as *S. apiculatus*. The two months named were also those in which bacteria appeared in the largest numbers. Amongst the observed organisms the mould-fungi were the most abundant, next came the bacteria, and lastly, the *Saccharomyces*. In both places of observation (under cherry trees and vines), the same organisms were generally found to be most abundant.

Amongst the most important results of experiments made in various breweries are the following: The vapour of the malt did not, as one might have supposed, carry away the bacteria and other organisms which are in the body of the malt. The air in the malt-house at Alt-Carlsberg infected all the opened retorts; the mould-fungi were especially abundant here. In the fermenting chamber of another brewery foreign yeast-fungi, which produced disturbance in the manufacture, were commonly met with. The air in the fermenting chamber at Alt-Carlsberg was distinguished for its great purity, it contained even fewer organisms than the air of the garden. This is ascribed to the fact that the air in this cellar is cooled by refrigerators,

* Résumé des Meddelelser fra Carlsberg Laboratoriet, i. (1882). See Bot. Centralbl., xi. (1882) pp. 6–8. Cf. this Journal, ii. (1882) p. 234.

and besides is washed with a shower-bath of sodium chloride. The researches have thus clearly shown of what importance pure air is to the process of fermentation.

With regard to the limits of the species of *Saccharomyces;* it has been shown that there is a group, which after it has undergone a certain more or less weakening treatment, has a tendency to form elongated instead of oval cells when introduced into a favourable nutrient solution. On the other hand, there are some which in the process of weakening itself form elongated cells. The different species behave differently during this process. The time occupied in similar modes of cultivation up to the formation of the so-called ascospores is likewise an important guide in the discrimination of the different forms. In this cultivation temperature plays an important part, though not so important as Reess has stated; low temperature for instance is not favourable, but rather checks development. The maximum, best, and lowest temperatures also vary for the different species.

The inverting power of fungi is not so universal as was formerly supposed; and this and the power of alcoholic fermentation may be combined in various ways in the different fermenting organisms.

Finally, with regard to *Oidium lactis* and *Chalara;* the small yeast-like cells which Pasteur calls Torula were carefully studied; with the result that these so-called Torula forms constitute physiologically several well-defined species, though morphologically they are not to be distinguished from one another.

Schizomycetes and Schizophyceæ.*—In connection with his previously published views on the relationship between the lowest forms of fungi and algæ,† W. Zopf describes a Schizophycea to which he gives the name *Gliothrix tenerrima*, and which appears as a fœtid greenish or dusky yellow slime on the surface of water. The filaments are of extreme tenuity, resembling the finest Schizomycetes. It is formed, however, only in the light, and gives the spectrum of chlorophyll. Its course of development resembles closely certain Schizomycetes, as *Bacterium cyanogenum*, occurring in the three states of zooglœa-colonies, and in the filamentous and spherical forms. Transitions from longer to shorter rods and to cocci occur in the same filament. The cocci might be regarded as belonging to the genus *Aphanocapsa*, the rods to the genus *Aphanothece*. The colonies deliquesce readily in water from the swelling of the jelly. When thus liberated the cocci have a power of spontaneous motion.

Another interesting illustration of the genetic connection of chroococcaceous forms and filamentous Schizophyceæ is furnished by *Phragmonema sordidum* belonging to the Sirosiphoneæ, which caused a dirty greyish-blue coating on leaves of *Ficus barbata* in an orchid-house. In this also chroococcaceous zooglœa-colonies are formed by the cylindrical cells of the filament becoming strongly rounded

* SB. Bot. Ver. Prov. Brandenburg, 1882, pp. 51–5.
† See this Journal, ii. (1882) p. 545.

off, and then finally separating from one another. In these cells repeated bipartitions take place, even before they become isolated, colonies of cells being thus formed, which attain a zooglœa-character from the gelatinizing of the cell-walls. These zooglœa-cells develope into unicellular or bicellular rods.

A Schizomycete to which the author gives the name *Bacterium merismopœdiodes* occurs in the form of colourless cocci which do not develope into rods. The cocci form rectangular more or less regular unilamellar colonies, the number of cells being always a power of two, which may amount to 64 × 64; and a number of colonies may coalesce from the disappearance of their enveloping membranes. Finally, when the substratum is exhausted, the cells separate themselves from their combination, and become motile. These develope into long filaments, which divide up into rods and finally into cocci; and the cocci, when isolated, are again motile and form merismopœdia-colonies.

In another publication,* the same author adduces further evidence that all the genera of Schizomycetes described by Cohn and others as distinct, viz. *Micrococcus*, *Bacterium*, *Bacillus*, *Leptothrix*, *Cladothrix*, *Vibrio*, *Spirillum*, *Spirochæte*, *Ophidomonas*, *Monas*, &c., are simply different stages of development. This applies even to the spiral forms, *Vibrio* and others, with respect to which it had not previously been suggested. The various forms of development are, as in the higher fungi, dependent on conditions of nutrition.

A special description follows of the following peculiar forms :— *Cladothrix dichotoma*, *Beggiatoa alba* and *roseo-persicina*, and *Crenothrix Kühniana*.

Microphytes of Caries of the Teeth.†—W. Miller states that an examination of the microphytes which accompany caries of the human teeth does not confirm Koch's view that the coccus- bacillus- and spiral forms of pathogenous schizomycetes are morphologically constant and genetically distinct. The *Leptothrix buccalis* occurs in all three forms. The entrance of this schizomycete into the tooth is preceded by a disappearance of the lime from the enamel and dentine, occasioned by acids formed in the mouth. Miller asserts the remarkable fact that a saccharomycete (*Saccharomyces Mycoderma ?*) sometimes perforates the enamel of sound teeth, making way for the entrance of the *Leptothrix*.

The first stage in caries of the teeth, the removal of lime from the tissue, is caused principally by acids produced by fermentation in the mouth. The enamel then gradually disappears, while of the dentine a porous mass remains, which affords entrance to abundance of *Leptothrix* in the bacillus and micrococcus form. The filaments of *Leptothrix* occur only on the surface or in the upper much-decayed layers, and appear to take but little part in this invasion. The bacilli, on the other hand, penetrate deeply, even into the finest ramifi-

* Zopf, W., 'Zur Morphologie der Spaltpflanzen.' Leipzig, 1882 (1 pl.). See Bot. Centralbl., xii. (1882) p. 217.

† Archiv für experiment. Pathol. u. Pharmakol., xvi. (1882). See Bot. Centralbl., xii. (1882) p. 231.

cations of the canals; the micrococci deepest of all. In the canals may frequently be seen a gradual transition from the long to short bacilli, and from short bacilli to micrococci. The schizomycete causes pathological changes in the lower layers, stops up the canals, and destroys the fibrilli, by which the transport of nutriment to the outer layers is entirely cut off, and they, in consequence, die and decay. The entrance of the fungus is always preceded by the attack of acids. The fungi cannot remove the lime from the solid tissue of the tooth, so that actual infection of a perfectly sound tooth by a carious one cannot take place. The first stage of caries is therefore a chemical one, the extraction of a calcium-salt; the second a pathological one, the death of the tissue by the destruction of the fibrilli of dentine; the third, a process of decay of the dead tissue. The first and third of these stages can be reproduced outside the mouth.

Bacilli in Condensed Aqueous Vapour of the Breath of Phthisical Persons.*—A. Ransome condensed the aqueous vapour of the breath of persons in an advanced phthisis, by the method he invented some years ago (1869); the method of staining used was that of Heneage Gibbes, magenta and aniline being used, discharged by dilute nitric acid, and chrysoidin then added. It was found that in the aqueous vapour obtained from two persons suffering from phthisis, there was a bacillus which took the staining in the same manner as the bacillus found in phthisical sputa and in tubercle, and which is indistinguishable from that organism. In some cases the experiments were unsuccessful.

Bacillus tuberculosis.†—Dr. H. D. Schmidt has published the result of his investigations into Koch's *Bacillus tuberculosis*, and asserts that it is not a *Bacillus* but simply a fat crystal! It is impossible to deal seriously with the paper, notwithstanding that it is written by an ex-President of the Pathological Society of New Orleans, who has been occupied for some years in work with micro-organisms.

Bacteria of the Air and Soil.‡—In continuation of previous experiments carried on in the laboratory in the Park of Montsouris, P. Miquel gives the result of a number of observations on the quantity of bacterial germs present in the air in different localities under different circumstances. Notwithstanding temporary fluctuations, a general law was observed with regard to the number of germs present at different seasons of the year; as a rule, it attains its maximum in autumn, its minimum in winter and spring. While rain is falling, the number of bacteria in the air is greatly reduced; it increases as the ground dries, and again diminishes when the drought has lasted for 10 to 15 days. The average number of bacterial germs per cubic metre of air is given for the autumn quarter 142, the winter quarter 49, the spring quarter 85, and the summer quarter 105.

* Proc. Roy. Soc., xxxiv. (1882) pp. 274–5.

† 'Louisville Medical Herald,' iv. (1883) pp. 459–76 (6 figs.).

‡ Extr. de l'Ann. de Montsouris pour 1882, 118 pp. See Bot. Centralbl., xii. (1882) p. 307. Cf. this Journal, iii. (1880) p. 837; ii. (1882) p. 88.

The smallest number during any month was 17 in February; the largest, 197 in October.

Similar tables are given of the number of germs in the air in Paris. February is still the lowest month, but the highest are June and July; and the average number is nearly ten times as large as at Montsouris. Of these bacteria, 93 per cent. were micrococcus, 5 per cent. bacillus, and 2 per cent. bacterium. In hospitals the number of germs is very much larger still, amounting, even during the summer months, to an average of 5600 per cubic metre, and in the autumn to considerably over 10,000. M. Miquel considers the air of hospitals to be a very large source of infection for contagious diseases, such as small-pox, scarlet fever, diphtheria, erysipelas, typhus, &c.

An examination of the bacteria in the soil showed at Montsouris an average of 750,000; in the Rue de Rennes, 1,300,000; in the Rue Monge, 2,100,000 germs per gramme.

A curve representing the number of bacteria present in the air very nearly corresponds with a curve of the weekly mortality of Paris, published under the authority of M. de Bertillon in the 'Bulletin de Statistique Municipale.'

The presence of ammoniacal (urine) ferments in the air is also discussed. These he shows to be of three kinds, *Micrococcus ureæ*, *Bacillus ureæ*, and *Torula ureæ*. Of the first he found 71, of the second 19, of the third 10 per cent.

Bacterium photometricum.* — T. W. Engelmann has further investigated the remarkable properties of the bacterium sensitive to light discovered by him,† which he finds in great quantities in the branch of the Rhine at Utrecht in company with amœbæ, *Lecythium hyalinum*, *Polytoma uvella*, *Oxytricha micans*, and *Anguillula*. He considers it an admirable test for the diathermancy of any medium for the invisible ultra-red rays of the spectrum.

A local accumulation of the bacterium was caused in a drop with the assistance of the microspectral objective, with as wide and intensely illumined a slit as possible. By gradually narrowing the slit the characteristic accumulation of the bacterium in the ultra-red between wave-lengths 0·8 and 0·9 μ was brought about; and it was ascertained how much the slit could be narrowed without entirely dispersing the bacteria. The slit was now slightly widened, and as soon as the quantity of bacteria in the inner ultra-red had increased, the medium to be tested was inserted between the source of light (heliostat or gas-flame) and the mirror of the microspectral objective, and the slit again narrowed to the greatest possible extent consistent with a considerable accumulation of the bacteria in the ultra-red. In other cases, after the first determination, the slit was widened to its utmost extent, and, after insertion of the medium, again narrowed to the minimum. In others again, commencing with a closed slit, the smallest opening was ascertained with which within a definite time

* Pflüger's Arch. f. Physiol., xxx. (1882) pp. 94–128 (1 pl.).

† Cf. this Journal, ii. (1882) pp. 656 and 661.

(say three minutes) a distinct accumulation of bacteria in the ultra-red was visible.

Although the changes in the sensitiveness of the reagent and other circumstances prevented accurate measurements in all cases, those cases are of special importance in which the insertion of the absorbing medium had no effect on the photo-kinetic reaction. For the evident reaction in both cases with the same minimum width of slit shows conclusively that the medium experimented on is highly permeable for the group of rays in question.

Absolute diathermancy for the inner ultra-red rays between 0·8 and 0·9 μ wave-length was determined in this way for all colourless transparent media, e. g. glass, water, concentrated solution of alum (these three in layers up to a thickness of 10 cm.), crystals of alum (0·3 cm. thick), the aqueous humour, vitreous humour, crystalline lens, and cornea of the eye. Also some coloured media, as alcoholic solution of chlorophyll (in transmitted light red and nearly opaque), and to a considerable extent thin light-green ivy leaves, and blue moderately dark cobalt-glass. In all these the outer visible red rays also passed through readily. Green and blue-green glass, although comparatively very transparent, caused great weakening of the ultra-red group; and they also greatly weakened the outer visible red rays.

A special interest was attached to the experiments on the media belonging to the eye, as affording a contribution to the solution of the question as to the cause of the invisibility of the ultra-red rays. Previous experiments, especially those of Franz and Tyndall, have sufficiently shown that the cause lies in the want of sensitiveness of the elements of the retina, not in the impermeability of the media of the eye for "dark heat." But it is still of great interest for this to be proved for the outermost visible rays nearest to the ultra-red, which have not hitherto been isolated, or at least not in the limited space and sharp definition which can be effected by the photometric bacterium. Since the experiments with it show the apparently perfect permeability of all the media of the eye for this group of rays, they prove that the limit of visibility of the spectrum at the red end is also the limit for the sensitiveness of the elements of the retina for less refrangible rays.

In these experiments the microspectrum was projected into the drop by means of one of Zeiss's lower objectives, B or C. The source of light was the flame of a large Sugg's gas-burner, placed at a distance of 1 in. from the mirror of the microspectral apparatus. The Microscope was placed in a dark box. Under these conditions, when the rays fell directly a very distinct accumulation of the bacteria in the inner ultra-red took place, even with a width of slit of from 0·01–0·02 mm., although the intensity of the light was then so small that the detection of the bacteria became somewhat difficult even in the bright part of the spectrum with very powerful magnifying. For this reason a somewhat low-power objective C, and eye-piece No. 3, were used.

A glass vessel with flat parallel walls 3·5 cm. wide and high, and

0·5 cm. thick, was now placed between the flame and the mirror, and filled with the vitreous and aqueous humours from four fresh bullocks' eyes, it having been previously ascertained that the same vessel filled with water or concentrated solution of alum produced no visible effect. The screen produced no sensible difference; within three minutes after the opening of the slit to a width of only 0·01 mm., a strongly marked accumulation was seen at the characteristic spot. A repetition of the experiment at a different part of the same drop produced the same result. The four crystalline lenses of the same eyes were now also placed between the mirror and the glass vessel in such a way that no light could pass except through them. The intensity of the light was so much diminished that it was extremely difficult, when the slit was increased to a width of 0·02 mm., clearly to make out the bacteria in the yellow rays; and the lower objective B was therefore used. With a width of slit of 0·01 mm., a very distinct accumulation of the bacteria in the ultra-red was still visible. This experiment was also repeated, with the same result, in a different part of the same drop. Finally, the four corneas were also inserted. Although still moderately transparent, they nevertheless considerably diminished the intensity of the light; yet with a width of slit of from 0·01–0·02 mm. there was still a distinct accumulation of bacteria. The reaction was so strong that it was evident that, with the normal transparency of the corneas, it would not be perceptibly weaker than without them.

The author considers it certain that these reactions do not, like the photokinetic movements of *Navicula* or *Paramœcium*, depend simply on changes in the tension of oxygen. They resemble more closely the movements of *Euglena*, inasmuch as they depend on sensitiveness to light, but are more complicated. They display most resemblance, however, to the sensitiveness of the eyes of higher animals.

Crystallizable Substance produced by a Bacterium.*—U. Gayon describes a bacterium, smaller than *B. Termo*, obtained from milk or from the bouillon of veal or chicken. When this bacterium is sown in a vessel containing pure milk, it rapidly becomes of a yellowish-green colour, its caseum coagulates, and at the end of some days green crystals appear on the walls of the vessel, especially near the air. With neutral bouillon of chicken, a beautiful green dichroic fluid is obtained, from which the crystals separate with difficulty. The crystals are insoluble in water, soluble in alcohol, ether, benzin, bisulphide of carbon, chloroform, ammonia, acetic acid, &c.

Algæ.

Reduction of Sulphates by Algæ.†—A. Étard and L. Olivier state that a microscopic examination of *Beggiatoa*, which is especially abundant in sulphurous waters, shows that the protoplasmic mass of

* Bull. Soc. Bot. France, xxviii. (1881) p. 321.
† Comptes Rendus, xcv. (1882) pp. 846–9.

its cells contains dark particles soluble in ether, chloroform, and especially in bisulphide of carbon. These particles disappear when the organism is transferred to water destitute of sulphates, and can be seen, on the other hand, to be formed within filaments in liquids rich in calcium sulphate. They are uncrystallizable, and consist simply of a deposit of sulphur.

The large blue filaments of *Oscillaria* were found to possess a similar property of withdrawing sulphur in the form of very fine granulations from water containing sodium or calcium sulphate in solution; while very fine filaments of the same alga appeared to possess no such power. Two species of *Ulothrix* presented similar phenomena.

The exhalation of sulphuretted hydrogen from sulphurous waters is, then, due to the power possessed by these algæ of removing sulphur from the sulphates contained in solution in them. The organic matter in these waters consists of these low organisms, and is not, as frequently stated, contained in solution, becoming insoluble only on exposure to the air.

Morphology of Marine Algæ.*—G. Berthold enters into a very detailed description of the morphology and physiology of certain marine algæ in respect to the following points:—

1. Heliotropism. The observations relate especially to *Antithamnion cruciatum*, *Derbesia marina*, and *Ectocarpus humilis*. In addition to ordinary positive and negative heliotropism, Darwin and Frank assume the existence of a third force, which they call diaheliotropism or transverse heliotropism, in virtue of which the growing point places itself at right angles to the incident rays of light. Berthold sees no necessity for this assumption.

2. The factors that determine the structure and mode of growth of the thallome of algæ. The algæ specially investigated are *Antithamnion cruciatum*, *Pterothamnion Plumula*, and *Spermothamnion flabellatum*. They refer especially to dorsiventral curvature in reference to the effect of light.

3. Contrivances for protection against too intense illumination, with special reference to *Chylocladia*, *Chondriopsis*, and *Bryopsis*. These consist of different forms of hair, belonging to several different types which characterize different families. A similar object is gained by the strongly refractive substances contained in the protoplasm which give to many algæ their brilliant appearance. The calcareous deposit in the thallome of *Corallina*, *Halimeda*, &c., answers a similar purpose.

Vaucheria.†—Dr. M. C. Cooke writes that the structure and development of *Vaucheria* has been so often and so well studied and illustrated that the observation of any new feature is quite unexpected, and will encounter some opposition, or at least excite some doubt. One of the generally accepted conclusions is, that the threads of *Vaucheria* are continuous throughout their length, only presenting

* Pringsheim's Jahrb. f. Wiss. Bot., xiii. (1882) pp. 569–717 (4 pls.).
† Grevillea, xi. (1883) pp. 104–6 (1 pl.).

septa at the time of reproduction when the short branchlets are isolated for that purpose. At all events, successive septation of the main filament does not appear to have been recognized by any one who has written upon this family. Of its development it is stated that the lower part of the germ-cell grows out into a branched, pale-coloured root, and the upper part is elongated in a still more considerable degree into a stem-like filament, which grows on and on by apical development until its growth is finally arrested by fructification. That is, in effect, the recognition of *Vaucheria* as unicellular.

During the keen weather at the commencement of the present winter, Mr. F. Bates collected some filaments of *Vaucheria* from under the ice, and upon submitting them to the Microscope discovered that the main threads were much divided by septa. Dr. Cooke received portions of these threads mounted, and as there was no positive evidence of the filaments belonging to *Vaucheria*, he was prompted to affirm that some filaments of *Cladophora* must have been mixed with the *Vaucheria*, for not only were the threads distinctly septate, but there was an accumulation of plasma in the cells, and an appearance as of differentiation. Subsequently, however, all doubts were removed, for in a part of the gathering were seen the oogonia and antheridia so characteristic of *Vaucheria* seated on filaments which, at a short distance, were septate in a similar manner to the previously examined thread. The whole gathering showed a great preponderance of septate filaments, divided completely, and somewhat constricted at the joints, some of the cells being two, and others three times the diameter or more in length; filaments which did not bear oogonia, or only one or two, being most divided so that Dr. Cooke was compelled against his first impression to accept the fact that the filaments of this undoubted *Vaucheria* had been divided off into cells at the period of fructification.

The question which at once suggested itself was—as to the object of this septation. And here it may be suggested that the single asexual zoospore, produced in small numbers, and the single oospore produced in the oogonium, always has appeared to be a very sparse provision for the reproduction of the species, as compared with the large number of zoogonidia which are produced in every fertile cell of *Cladophora* and *Chætomorpha*. Even in the *Botrydiaceæ*, the multiplex modes of reproduction are strongly in contrast with what has been known as the reproductive process in *Vaucheria*. For these reasons there does not appear to be any improbability in the supposition that zoogonidia may be produced in *Vaucheria*, in cells divided off for that purpose. The formation of the cells, the accumulation of the cytioplasm, acquiring density and, as he strongly believes, differentiation, lend strength to the probability that reproduction by zoogonidia may yet be discovered in *Vaucheria*. No active zoogonidia were detected, but bodies were seen of a definite form, resembling zoogonidia at rest, in the cells; and in the water in which the gathering was kept were found similar bodies outside the threads, some in a state of germination. It must not be supposed that the

author affirms, or has direct evidence to affirm, either that zoogonidia *are* produced in the cells, or that the free germinating bodies are escaped zoogonidia; but these circumstances are mentioned as showing how necessary it is that *Vaucheria* should again become the subject of investigation for the purpose of discovering beyond doubt what is the cause and true interpretation of this unsuspected septation of the filaments.

Rejuvenescence of the Thallus of Vaucheria.*—It has been known since the time of Hanstein that the thallus of *Vaucheria* remains unseptated so long as it is in a purely vegetative condition; but that if a filament is injured, the protoplasm of the uninjured part immediately contracts, and protects itself by a septum which shuts it off from the injured part. J. Schaarschmidt has repeated Hanstein's observations with similar results. Filaments of *V. sessilis*, when injured, immediately repair themselves in this way, but no longer have the power of reproduction; they break up into gemmæ, which remain for a shorter or longer time in this condition, and then germinate, producing new filaments. Gemmæ are also formed on uninjured filaments, going through a great change of form before germination. In this condition they greatly resemble *Gongrosira*, but still more the protoplasm-tubes which are put out from the zoosporangia on the rhizoids of *Botrydium granulatum*.

A similar but less marked power of rejuvenescence was observed by Schaarschmidt in *Conferva bombycina*. A portion of the contents of the injured apical cell invested itself with a double membrane, and separated itself from the injured cell.

Assimilation of Hæmatococcus.†—T. W. Engelmann has applied his bacterium-method for the determination of the elimination of free oxygen ‡ to decide the question whether algæ in the red resting condition, especially *Hæmatococcus* and *Chroolepus*, disengage oxygen or not; Rostafinski having stated § that the former of these organisms has the power of assimilating, although destitute of chlorophyll. By the method named, Engelmann determined the elimination of oxygen, but also that chlorophyll is contained in a peripheral layer of the protoplasm of *Hæmatococcus*, the quantity being, however, always small. The green colour is usually masked by the red pigment, although occasionally evident.

In the Oscillarieæ and diatoms, on the contrary, the presence of chlorophyll could not be determined in this way; and the chlorophyll, if present, is mixed with other colouring matters which have also assimilating properties, or chemical compounds are present which are affected by light in the same way as chlorophyll, but differ from that substance in respect to the relative activity of the different rays of light. For these hypothetical substances he proposes the name "chromophylls."

* Magyar növénytani Lapok, vi. (1882) pp. 10–13. See Biol. Centralbl., ii. (1882) p. 513.

† Bot. Ztg., xl. (1882) pp. 663–9.

‡ See this Journal, i. (1881) p. 962, ii. (1882) p. 661.

§ Ibid., i. (1881) p. 930.

Movements of Oscillarieæ.*—A. Hansgirg has investigated the cause of the movements of Oscillarieæ, and especially their relationship to light. The filaments of *O. Frölichii*, placed in complete darkness, were found to have lost on the second day their mucilaginous envelope, and to have sunk to the bottom of the vessel. The twisting and creeping movements, however, continued till the seventh or eighth day, becoming gradually weaker. The more sensitive filaments of *O. ærugineo-cærulea* lost their power of motion more rapidly. In direct sunshine the movements were more lively than in diffused daylight. An increase in temperature of the water also promoted the rapidity of the movement.

The separate filaments of a cluster move with different degrees of rapidity, depending not only on warmth and light, but also on the age of the filament; the quality of the water, whether spring, river, or stagnant water, also has an effect. The twisting and nodding movements the author believes to be due, not to their growth, but to osmotic changes in the cell-contents. The creeping movements, he holds, cannot be due to protrusions of the internal protoplasm, since each filament is enveloped in a gelatinous sheath, which is not composed of protoplasm. The cells also exhibit motion when the envelope itself is at rest. The movements must originate in the protoplasmic contents themselves of the cell, and are probably of the same nature as those of the sarcode in the so-called pseudopodia of rhizopods and other protozoa.

Movements of Diatoms.†—Dr. J. Hogg comes to the conclusion that these movements are not to be explained upon any endosmotic and exosmotic theory or on that of an undulating protoplasmic membrane; nor are they due to cilia arranged throughout the sutural line of the frustule or projecting from the openings at the extremities. In his view the movements are caused by contractile prehensile filaments.

"By attentively following a diatom, under high power magnification and careful illumination, its movements are seen to be under its own control. It will attack a body relatively larger than itself; it will force the sharp or taper end of its frustule into a mass of matter, and recede from it, with a jerky motion. This action it will repeat many times over or until it has opened a way for itself. Such movements will be explained by the alternate extension and retraction of a delicately constructed prehensile organ, or organs, contractile prehensile filaments, protruding through an opening or operating on the external surface of the siliceous frustule. It is but necessary to have prehensile filaments capable of extension, in the transverse direction of each half of the frustule, to which they may be attached, to further comprehend the forward and backward movements performed by the diatom. For a nearly parallel example I may refer to the pediculate rotifer: the pedicle of which consists of a highly contractile spiral style. This the rotifer alternately expands and

* SB. K. Böhm. Ges. Wiss. Prag, June 9, 1882. See Bot. Centralbl., xii. (1882) p. 361.

† Sep. repr. from Mém. Soc. Belg. de Micr., 1883, 11 pp. Cf. Report of Referee in Bull. Soc. Belg. Micr., ix. (1883) pp. 37–44.

contracts at will; and performs as is well known many very active movements. Take another example from amongst the simpler forms of life—cryptogamic plants, whose spores, possessing contractile filaments, have considerable powers of extension and contraction, and are otherwise employed as motile agents. We may then without further argument assume that diatoms are furnished with a somewhat similar agency, whereby their movements are effected. . . .

Somewhat conclusive evidence of the prehensile contractile filamentous theory is, I believe, furnished by the addition of a minute quantity of colouring matter to the contents of the cell in which the diatoms are confined. When a particle or two of colouring matter comes within reach of a filament, it is seized upon, and follows the subsequent movements of the diatom. Occasionally a coloured particle will be seen to be affected in the following manner. At a point equal to the length of the frustule, it is grasped *en passant;* or it may be seized at some intermediary distance of the extreme limit of the prehensile filament, when it is instantly drawn towards the frustule with a jerky motion, and secured. On more than one occasion, a cell of *Palmoglœa* was seized in the way described, and seen to travel along the longitudinal sutural aspect of the valve, and in a contrary direction to that of progression, the progress of the frustule being at the moment perceptibly slower and somewhat more jerky. When not so engaged it appeared to be occupied in securing *points d'appui* on the slide and cover-glass. Any and every movement, however, must be performed at some disadvantage in so confined a space as that afforded by a very shallow cell: a succession of normal movements is scarcely possible under the circumstances. . . .

In once again entering upon the investigations of the movements of diatoms, I have been anxious to divest myself of all preconceived opinions, of either cilia or other organs, and having obtained during the past summer a bountiful supply of lively specimens, I at once made them the subject of careful and prolonged study. Portions taken from the bulk, together with cells of *Palmoglœa*, were transferred to a growing-slide, the last named being arranged in groups of from two to a dozen or more primary cells. By expansion of the transparent outer membrane these cells soon displayed the phenomenon of self-division; but neither in the compound state nor as single cells did any of them exhibit any other kind of motivity. The diatoms, on the contrary, were incessantly on the move, passing to and fro, over the field of the Microscope. Now and again they would seize upon a *Palmoglœa* and carry it off. Any retraction of the contractile filament of the diatom produced a sudden jerky movement of the cell; but as soon as it relinquished its hold it returned to a state of perfect rest. Occasionally a fresh attack was made and the cell was seen to follow in the track of the diatom. The movements were so remarkable, that no one observing them could, I venture to think, refer them to other motile organs than that of prehensile filaments or other voluntary contractile bodies under the perfect control of the frustule.

At another time a minute organism belonging to a different genus would dart across the path of a diatom or come into contact with it,

when it was at once seized and for a moment arrested. Two *Naviculæ* would cross each other, and the resultant action would be of an intermediary or restraining character, and on suddenly relinquishing their hold of each other they would separate with a bound. At another time the motive action of a diatom was seen to be of a halting nature, as if waiting to gather up its contractile organs before attempting any advance."

On the other hand, Dr. E. Van Ermengem* says that notwithstanding the use of various colouring reagents (aniline colours, hæmatoxyline, and carmine), also osmic acid in solution and vapour, and absolute alcohol, homogeneous-immersion objectives of Zeiss (1-18th in.) and Tolles, and Abbe and Powell condensers, he has not been able to find the least trace of any kind of locomotor organs. The large species of *Pinnularia*, *Pleurosigma*, and *Surirella* which he observed were in full vitality and moved very actively. The frustules always seemed to him to move in an automatic manner as if they were impelled by a blind force, very different from the impulsive spontaneousness which seemed to animate the different Protozoa by which they were accompanied. A number of the diatoms had on their surface immovable filaments which were more or less slender, and strongly refracting—true epiphytes (*Leptothrix*) the nature of which it was difficult not to recognize.

Dr. Van Ermengem considers that there only remains to explain the motions of diatoms the hypothesis which attributes them to the action of purely mechanical forces, thermo-dynamical, and perhaps of electro-capillarity.

Markings of Diatoms.†—Mr. E. W. Burgess combats M. Prinz's views as to the existence of openings, and says that "if we examine a valve of *Trinacria regina* or *T. excavata* by direct light through the valve, focussing sharply to the flat surface of the valve, we get to the edge of the base of the areolæ, and viewing the areola we find that the colour is different to that of the field (outside the edge of the valve), proving that we are looking through the substance of the areolæ; and if the valve has its exterior towards the observer, we have to withdraw the objective by the fine adjustment to reach the apex of the areola; and if the interior is towards us, we lower the objective by the same means to reach the bottom of the pit or concavity of the areola.

The same observations apply to the valves of *Stictodiscus*, *Triceratium*, and others. If these diatoms are viewed by reflected light on a black background (if the valve has its exterior towards the observer), the areolæ catch the light, and would convince even the most sceptical observer that they are not openings, but either pits or spherules, such observations depending upon the side of the valve towards the observer."

* Report of Referee in Bull. Soc. Belg. Micr., ix. (1883) pp. 41–3.
† Microscopical News, iii. (1883) pp. 71–5 (8 figs.).

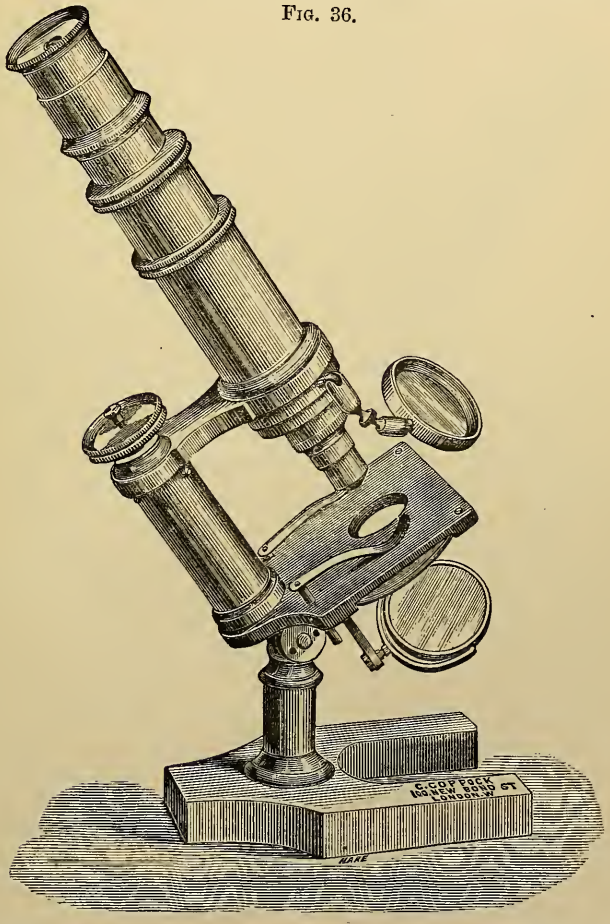
MICROSCOPY.

a. Instruments, Accessories, &c.

Coppock's Combination Microscope.—This Microscope has been constructed by Mr. C. Coppock mainly from data obtained from consultation with the leading teachers of science in Edinburgh.

The general form of the instrument is shown in fig. 36, the stage

Fig. 36.



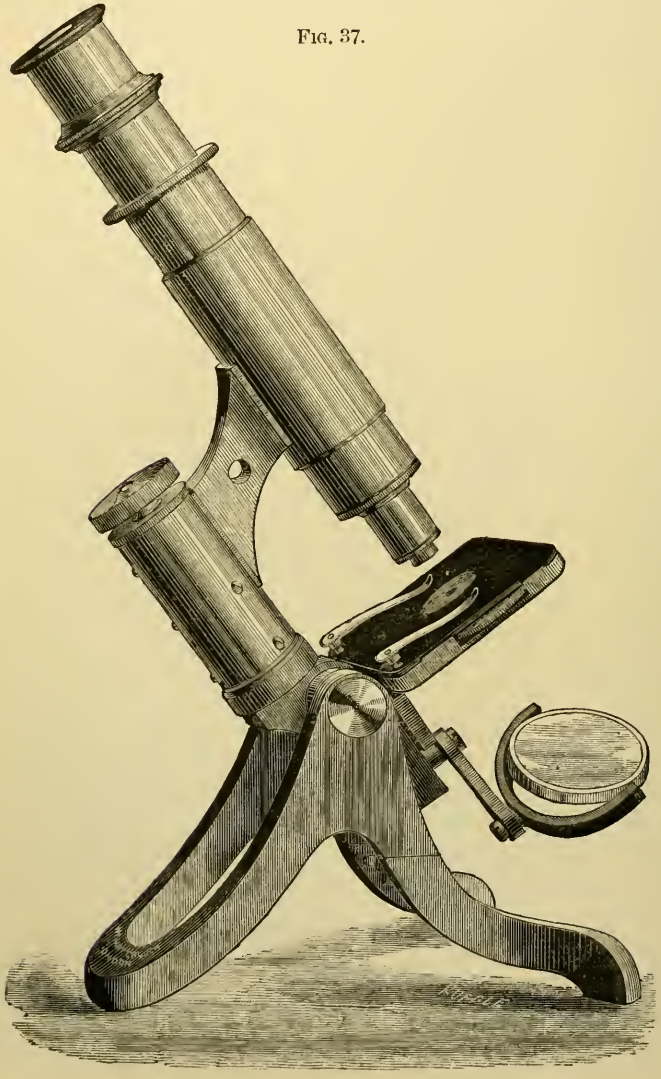
and body being carried upon a turned pillar, after the style of the Continental models, and the stage being as large as is consistent with the relative proportions of the whole instrument. The body-tube allows the highest objectives to be readily focussed by giving a slight spiral movement to the tube, and the draw-tube is stopped when drawn out to the normal nine inches. The side condenser is fixed by

a revolving annulus to the body. The revolving diaphragm plate is recessed into the stage. When the largest aperture is used, the thread in the stage will allow of a fitting being screwed into it to receive the various stage apparatus.

For class demonstration it is found that the hinged joint to the limb is not essential, and it is therefore made in two forms, with and without joint.

Crouch's Portable Histological Microscope.—Mr. H. Crouch has

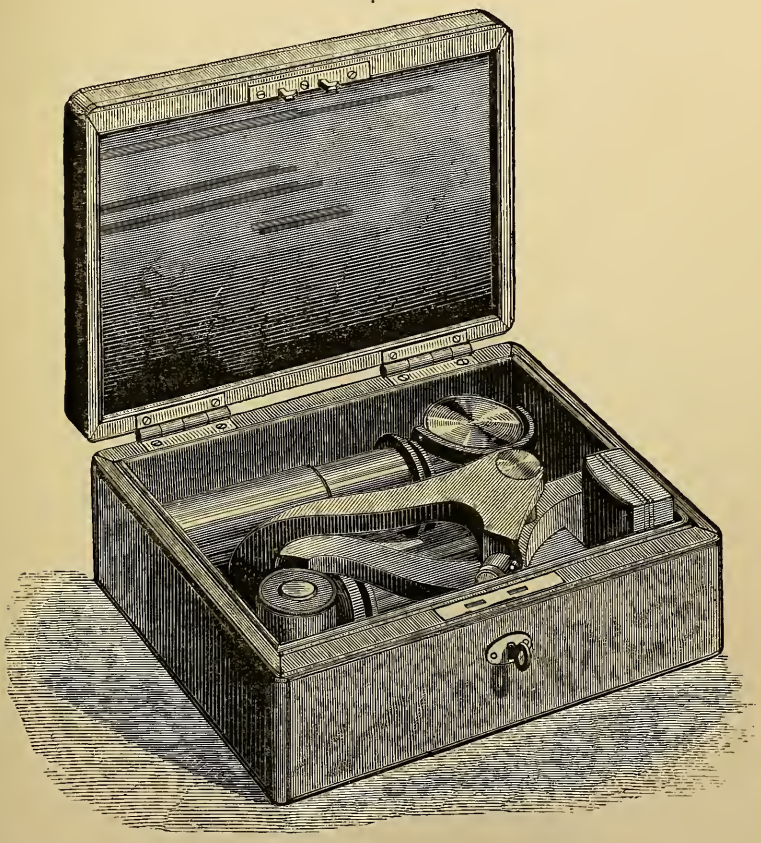
Fig. 37.



issued the instrument shown in figs. 37 and 38, with the view of providing a Microscope which shall combine portability with more steadiness than is usually found in "portable" forms. When set up for use the instrument is shown in fig. 37, and when folded in fig. 38.

The modifications adopted to enable the instrument to be folded

Fig. 38.



up are as follows:—(1) The stage is made to turn laterally at right angles to the normal position, so as to be in a line parallel with the body-tube, which permits the latter to be reversed and inserted at the lower end of the socket; and (2) the two front "feet" of the tripod are made to fold outwards and backwards under the heel.

In packing the instrument, a small milled screw beneath the stage is loosened, and the stage turned at right angles; the body-tube is removed, reversed, and put into the socket at the lower end; the limb

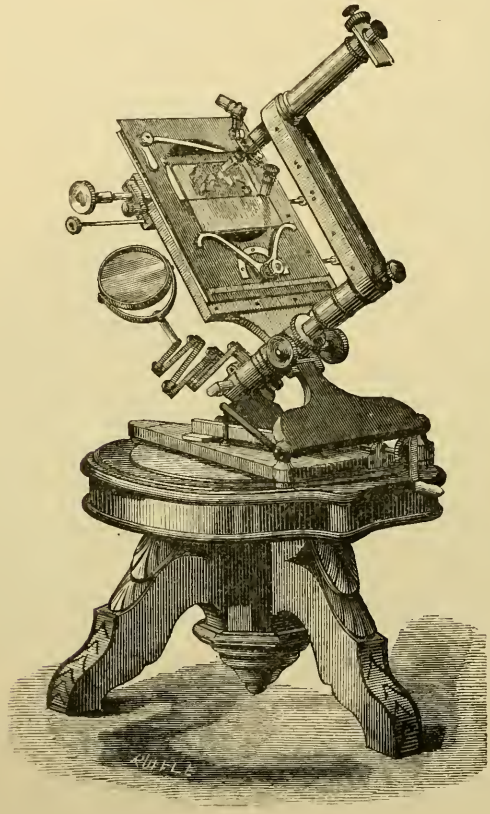
is inclined backwards on the trunnion axis as far as it will go, and the feet are turned back under the heel. Thus folded, the Microscope fits into a leather case 7 in. × 5 in. × 3 in.

The stage, which is only $\frac{1}{4}$ in. thick, contains between its upper and lower plates a diaphragm with four circular apertures, which is rotated by the finger acting on its projecting milled edge at the right-hand side.

Deecke's Large Microscope.—Dr. T. Deecke, special pathologist of the New York State Lunatic Asylum, sends us a description of this instrument (figs. 39–41)* from which the following is condensed:—

The stand became a necessity after he had succeeded in making

Fig. 39.

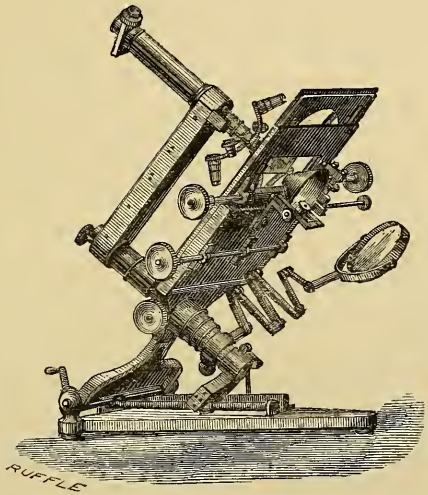


sections of 1-400th to 1-600th in. thickness, and upwards of 6 in. in diameter, in order to facilitate topographical investigations of minute

* The figures are drawn to a scale of about 1–12th actual size.

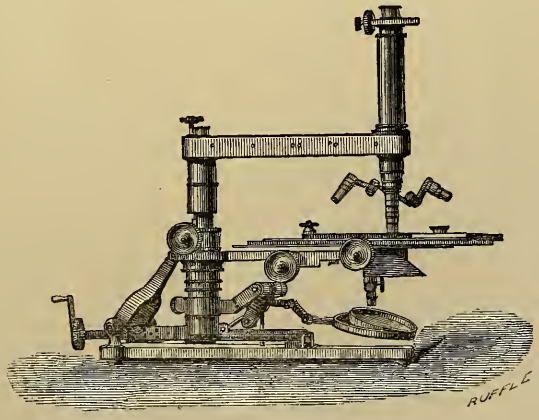
anatomical structure. It was constructed in 1876, and has since been in constant use for ordinary observations and photomicrography.

FIG. 40.



The application of a mechanical stage nearly 12 in. square, permitting 4 in. of motion in all directions from the optic axis, necessitated sundry modifications of design and construction from the usual models

FIG. 41.



in order to secure the utmost freedom for the various manipulations, together with the accuracy of movement required in using high powers.

The chief novelty is the system of inclining the Microscope from the vertical to the horizontal.

The foot is a heavy triangular plate, the base 14 in. and the two sides 19 in. There are two short pillars at the angles of the base which support by pivots a second triangle connected at the truncated vertex by a hinge with a shoulder-piece encircling the main column in which the coarse adjustment slides; the continuation of this shoulder in front is the fixed stage-plate carrying the mechanical stage. The lower end of the main column is provided with a female screw in a pivoted sliding box-fitting, in which acts a powerful 12 in. screw attached to the base-plate and controlled by a crank at the back. This screw causes the main column to travel from the vertical to the horizontal, the suspended triangle at the back moving correspondingly as a hinged stanchion.

The coarse adjustment is similar to that in the older Ross model; but two racks are applied to the column and two pinions are set on the same axis so that the teeth grip alternately in the racks, by which it is stated that lost motion is obviated.

The fine adjustment is also on the older Ross principle.

In consequence of the great length of the arm (13½ in.) carrying the body-tube, and to avoid flexure and tremor, the lever is constructed of two strong double bars connected by cross-bars like the beam of a chemical balance. It moves between conical steel fulcrum-points placed considerably in front of the centre, and very strong flat springs press against each end. Upon the posterior arm of the lever a micrometer-screw of sixty threads to the inch, acts, giving a focussing range of 1-8th in.

The mechanical stage rests upon the fixed rectangular plate which forms one piece with the shoulder encircling the main column. The mechanical movements (4 in. in all directions from the optic axis) are obtained by means of two sliding plates of the usual construction, but with modifications in the mechanism necessitated by the increase of size and greater range of motion. The lower stage-plate is 12 in. from behind forward and 11¼ in. wide, and the upper 12 in. by 11 in. The ordinary rackwork motion of the upper plate was found to be too coarse when high powers were employed, and an arrangement was therefore devised by which this rackwork can be disconnected and the plate then moved by a system of four endless screws on the left of the stage.

Stage clips of somewhat peculiar form allow a slide of any size from the ordinary one to upwards of 10 in. by 8 in. to be securely held. At the lower end of the upper stage-plate a pair of movable legs (like compasses) are applied on one axis, and can be set by a screw at any angle from 10° to 160°, the end-pieces being provided with grooves for the reception of the slides. An adjustable right-angled arm is attached to the upper left-hand corner of the same plate, and can be pressed against the slide.

A centering substage, carrying accessory apparatus, is also applied; it is provided with rack and pinion movement actuated by the small milled head on the right in fig. 40.

The mirror has seven jointed arms, and can be used above the stage for illuminating opaque objects.

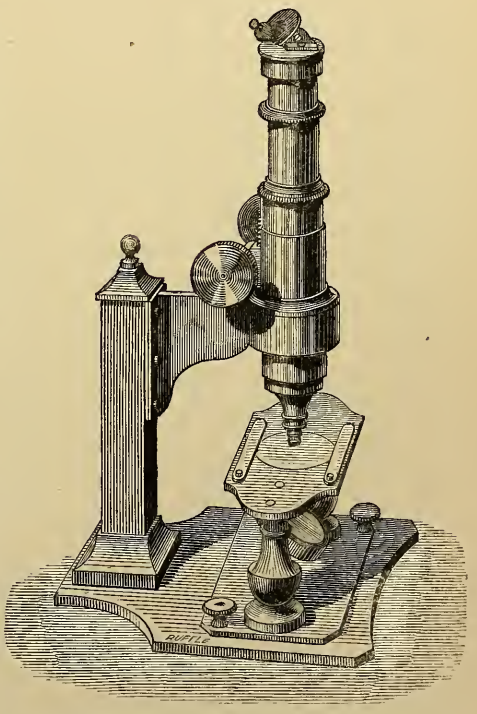
The whole instrument stands upon a strongly made tripod 15 in. high with revolving top 20 in. in diameter. When at an inclination of 45° the eye-piece is 3½ ft. from the floor.

The Microscope was constructed under Dr. Deecke's supervision, and from plans drawn by himself, at the "Utica Engine and Boiler Works" of Mr. P. S. Curtis, Utica, N.Y.

Dr. Deecke also sends us a description of a stage for use in photo-micrography for the purpose of rendering possible the focussing of large areas of sections when low magnifying powers are used.

An ordinary photographic lens can be successfully employed instead of the microscopic objective. It gives at a proper distance, of from 10 to 20 or even 40 ft. from the lens, a picture of excellent definition, but the great difficulty is to bring all parts of a field of such dimensions into the proper focus. Assuming that this difficulty probably originated in slight inequalities in the thickness of the sections in their different parts, or that it was due to their position in the mounting fluid between the slide and the cover-glass, Dr. Deecke corrected the defect by constructing a stage on which the specimen may be placed in any desired plane slightly oblique to a vertical plane drawn through the centre of the magnifying lens, and thus arrived at results which gave perfect satisfaction.*

Fig. 42.



Robin's (Chevalier) Dissecting Microscope.—This (fig. 42) is another form (by A. Chevalier) of Prof. C. Robin's Dissecting Microscope, that made by MM. Nachet having been figured on p. 100, Vol. II. (1882).†

* Description supplied by Dr. Deecke. See also brief note in Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 277–9. No little credit is due to Mr. G. W. Ruffle for engraving the above woodcuts from photographs very much wanting in clearness.

† Cf. also C. Robin's 'Traité du Microscope,' 1877, p. 75.

The stage is intended to be used with transparent objects. The central aperture receives either a wheel of diaphragms or a glass disk. An erecting prism is shown in place over the eye-piece.

When opaque objects are required to be observed they are placed on the base-plate, the plate carrying the two pillars, mirror, and stage being then removed by loosening the two clamp screws at the corners.

Rollet's Polari-spectro-microscope.*—This instrument was devised by Dr. A. Rollet, of Graz, and is a combination of a compound Microscope with a spectral and polarizing apparatus, he having observed, whilst experimenting on the spectra of the colours of thin plates, and the polarization colours of selenite films, that such a combination might be exceedingly useful for certain histological examinations.

The description of the instrument and its use is prefaced by some remarks on the spectroscopic eye-pieces hitherto designed, beginning with the original plan by which parts of a spectrum (or a small spectrum suiting the field) were projected in the plane of the microscopical object. This was effected by spectral apparatus fixed in *front of the objective*, and thus observations could be made on the behaviour of microscopical objects in monochromatic light.

Later the spectroscopic *eye-piece* was adopted, on the suggestion of Dr. W. Huggins, on the model of a star spectroscope, and afterwards improved by the spectroscopic eye-pieces, especially adapted for the Microscope, of Sorby and Browning, Zeiss, and others.

Each of these methods, however, serves different purposes; and careful consideration shows that it is only the older manner of examination which is adapted for true microscopical studies of a more extended application, the use of the spectroscopic eye-piece being much more circumscribed. In the latter the slit is at the point where the inverted image is formed by the objective and field-lens. A linear strip of this image is then spectrally analysed by a direct vision prism. Such an apparatus is excellently adapted for studying the absorption-spectra of uniformly coloured microscopical objects containing no inner contours, and whose images cover the slit either entirely or to a definite extent. It can also be used for the same purpose in the case of the absorption-spectrum of *one* particular absorbing substance which is associated with delicate bodies uniformly distributed in a liquid, as with the red blood-corpuscles or chlorophyll-grains. But in these cases the action of the eye-piece is satisfactory only if the object is somewhat above or below the focus of the Microscope. It is easy to see the reason for this, but an example will explain it more clearly. Place a drop of blood, spread out on a slide, under the Microscope, remove the prism of the eye-piece, and with the slit wide open focus so that the image of the blood-corpuscles may be as sharp as possible, then narrow the slit and replace the prism. A spectrum of unequal brightness will be seen, crossed by numerous dark lines and shadows at right angles to the direction of the slit, and in which both the Fraunhofer lines and the absorption-bands

* Zeitschr. f. Instrumentenk., i. (1881) pp. 366–72 (3 figs.).

will be indistinct and fragmentary. This will also occur if the edges of the slit are defective or if particles of dust have got in. In the case we are considering it is caused by the sharp outlines of the blood-corpuscles. If the Microscope is placed out of focus a uniformly bright spectrum will be obtained with sharp Fraunhofer lines, and the distinct absorption-bands of the hæmoglobin. A band of the

Fig. 43.

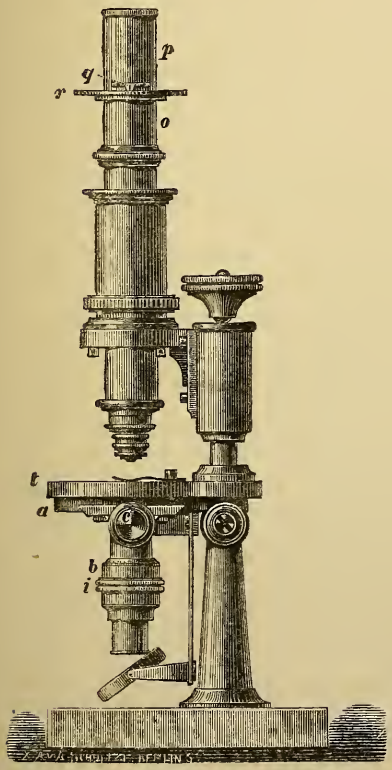


Fig. 44.

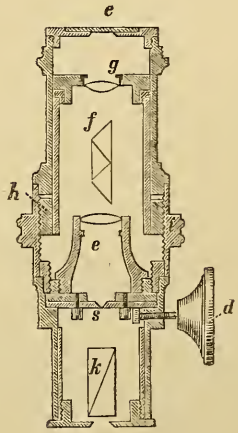
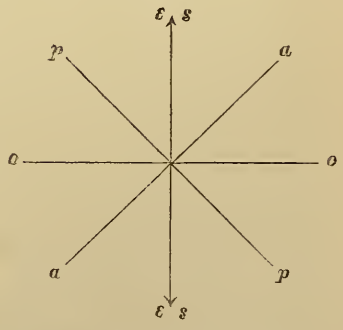


Fig. 45.



sharp image of the object is of course no longer spectrally analysed, but only a band of the circles of confusion, which now fall in the plane of the slit, forming there an indistinct image of the corpuscles. We have, however, in this way, removed the injurious action of their sharp outlines upon the clearness of the absorption spectrum.*

* Besides the value of the spectroscopic eye-piece for the study of absorption-spectra, Dr. Rollet mentions the use he has made of it in the examination of Newton's rings, and the polarization colours of crystalline plates.

"By the above remarks," Dr. Rollet says, "I imagine I have sufficiently shown that the use of the spectroscopic eye-piece in microscopy is somewhat limited, but if it be objected to this that Sorby has made exceedingly numerous observations by this means, it may be replied that these researches were concerned only with the discovery of the characteristic absorption-spectra of colouring matters, that is, always for the solution of a particular problem for which this eye-piece is eminently fitted. There are, however, a large number of problems in micro-spectroscopic research for which the eye-piece is not suitable, i. e. all those in which it is not merely required to examine the absorption-spectra of the colouring matters occurring in microscopical objects, but the objects themselves in monochromatic light, whether in any particular part or all parts of the spectrum. For such purposes the spectrum projected in the plane of the object must be used as it was employed before the introduction of the more recent eye-piece."

The following description is then given of the polari-spectro-microscope which was constructed by Schmidt and Haensch of Berlin, according to Dr. Rollet's directions.

To a Microscope (fig. 43) in which the stage is further than usual from the base, the following pieces of accessory apparatus are fixed.

I. Beneath the stage *t*, is a small spectroscope *b* attached to it by means of a metal plate *a* with an oval hole, and movable by the screw *c* horizontally from right to left in a slide applied to the metal plate.

The spectroscope consists of the following parts (fig. 44):—(1) The slit *s* adjusted by the screw *d*; (2) a collimator lens *e*; (3) a direct-vision prism *f*; and (4) above the prism a convex lens of short focus *g*, which is intended to project a small spectrum in the plane of the object on the stage. That this may be easily done with different objects, on slides of different thicknesses, the prism and the convex lens can be moved vertically, they being in one piece of tubing, while the slit and collimator lens are in another. This movement is effected by a screw *h* cut in the inner tube, and a ring *i* (figs. 43 and 44) on the outer, which act like the correction-adjustment of objectives. (The amount of the vertical movement can be registered on a millimetre scale, divisions on the ring showing fractions of mm.) The dispersion of the prism is such that with a medium magnifying power, the small spectrum projected in the plane of the object, can be completely seen in the field of the Microscope, from the red to the violet end and the Fraunhofer lines also clearly visible. (5) In front of the slit is a polarizing (Hartnack-Prazmowski) prism *k*, and (6) above the convex-lens is fixed a selenite film *e* (Red I. Ord. or Red II. Ord.).

II. Over the tube of the Microscope is an eye-piece *o* (fig. 43), above which a Hartnack-Prazmowski analysing prism is fixed. This is movable over the eye-piece by its tube *p* and its correct position is shown by an index *q* on the tube moving over a circular scale *r* fixed to the eye-piece.

The instrument, when intended to be used for the purposes hereafter mentioned, must be adjusted as shown in fig. 45, which represents a projection upon a horizontal plane of the parts interposed between the eye and the mirror.

s s	Direction of the slit.	
p p	„	vibration of the polarizer.
a a	„	„ „ analyser.
o o	„	„ „ ordinary ray in the selenite film.
e e	„	„ „ extraordinary ray in the same.

In this arrangement of the instrument, when sufficiently strong parallel rays are received from the mirror (either bright, diffused daylight, direct sunlight, petroleum- or gaslight), a dark interference-band will be seen in the spectrum in the field at the point corresponding to the Fraunhofer line E, which moves from E to F or E to D, more or less according to the tint of the selenite film.

The resulting intensity of the light proceeding from the analyser (apart from the loss at the surface) is under the above condition for every given colour

$$R^2 = r^2 \sin^2 \frac{\pi}{\lambda} d\,(\gamma - a), \qquad (1)$$

in which r^2 is the intensity of the incident light, λ the wave-length, d the thickness of the selenite film, γ the greatest and a the smallest principal refraction quotients of the selenite for the given wave-length. The dark interference-band appears in every part of the spectrum for which the condition

$$d = 2\,(n - 1)\frac{\lambda}{(\gamma - a)} \qquad (2)$$

is fulfilled. In this equation n is the ordinal number of the dark interference-band. It has the value 1 for the thickness o of the plate. The colour region red I. Ord., and purple II. Ord. (red I. Ord. of the ordinary selenite films) lies within the value 2, and the region red II. Ord. and purple III. Ord. (red II. Ord. of the ordinary selenite films) lies within the value 3 for n, whilst the value of λ for these regions lies between the 490 and 545 millionth-millimetre of Angström's scale; F Fraunhofer coinciding with 486, E with 527, and D with 589. The interference-band of the red II. Ord. is more sharply limited than that of the red I. Ord.

The object on an ordinary slide is now brought into the field of view (showing the spectrum with the dark interference-band) and is moved till it lies over this band. If the object is singly refracting it remains, in all azimuths, dark upon a dark ground. If it is doubly refracting, then it acts as a thickening of the selenite film when the vibration-direction of the ordinary (or extraordinary) ray in the object corresponds with that of the ordinary (or extraordinary) ray in the film. In the contrary case it acts as a thinning of the film. In both cases the doubly refracting objects are illuminated on a dark ground in the spectral colour extinguished by the interference-bands.

If, however, the spectrum is moved under the object by the

horizontal movement of the spectroscope before described, then in the first case there is a spectral region found towards the red end in which the doubly refracting object appears dark upon a bright ground; but in the second case such a region appears at the violet end, because with augmented or diminished thickness of the plate, the value of λ in the equation (2) is altered. With increasing thickness of the doubly refracting plate, the dark interference-bands move in the spectrum from the violet to the red end, and *vice versâ* with diminishing thickness.

By this method small degrees of double refraction in organized bodies can be more certainly discovered, and for certain histological objects a very safe opinion as to their double refraction can be arrived at. Dr. Rollet has employed the method especially for the examination of striated muscle-fibre, and obtained very good results as to the double refraction of the transverse, the accessory, and the terminal or intermediate disks. If we place a striated muscle-fibre upon the slide so that its longitudinal axis coincides with *es—es* (fig. 45) it will be in the so-called "addition-position" above the selenite film; all its above-mentioned doubly refracting parts will therefore be brightly illuminated in the dark interference-band. If, however, the spectrum is so moved that the spectral regions near the red end lie under the fibre, we obtain an image in a given region which is, as it were, the negative of the former, because all parts of the fibre which before appeared bright on the dark ground of the interference-band, now appear dark upon a bright ground. The second image thus checks the first.

Moreover degrees of double refraction may, in some cases, be distinguished by the extent of the movement of the spectrum which is necessary to obtain the negative image. If the selenite film is turned, while the fibre remains in the direction of the slit, so that not *e e* as in fig. 45, but *o o*, falls in the direction *s s*, then the fibre will lie in the "subtraction-position" above the film. The position in the spectrum of the interference-band of the film remains unchanged and the doubly refracting parts of the fibre shine as before on the dark ground. But now, in order to obtain the negative image, the spectrum must be so moved that a spectral region nearer the violet end lies under the muscle fibre. By this apparatus, therefore, addition and subtraction positions can be directly distinguished from one another.

With regard to the selenite films, the author remarks that these were chosen because they are easily replaced and are abundant in commerce. In the selection of the particular films mentioned above the position of their interference-bands was determined in the central part of the spectrum, so that there was the necessary space between that and the red and violet ends. It is, however, clear that exactly similar observations can be made with interference-bands in other spectral regions and of other orders, by the employment of thicker or thinner films than those which correspond to the red of the first or second order.

The use of interference-bands of a higher order is not suitable, because the increase in thickness, which moves them to a proportionate

extent out of their position in the spectrum, is always greater with increasing ordinal numbers. If the thickness, for which the dark interference-band between crossed prisms corresponds with G Fraunhofer, is

$$d = 2(n-1)\frac{\lambda_G}{2(\gamma_G - \alpha_G)}, \qquad (3)$$

but the thickness, for which the interference-band corresponds with B Fraunhofer, is

$$d' = 2(n-1)\frac{\lambda_B}{2(\gamma_B - \alpha_B)}, \qquad (4)$$

then according to (3) and (4)

$$d' - d = 2(n-1)\left[\frac{\lambda_B}{2(\gamma_B - \alpha_B)} - \frac{\lambda_G}{2(\gamma_G - \alpha_G)}\right], \qquad (5)$$

which shows that when the ordinal number n of the dark interference-bands ascends from unity to unity, the increase in thickness, which is necessary to move the band once from G to B through the spectrum, forms an ascending arithmetical progression.

The instrument can be used as a spectromicroscope alone, without the polarizing apparatus, or it can be employed as an ordinary Microscope if the spectral apparatus be also removed.

Vérick's Travelling or Pocket Microscope.—In this instrument (figs. 46 and 47) portability is obtained, not only by the usual expe-

Fig. 46.

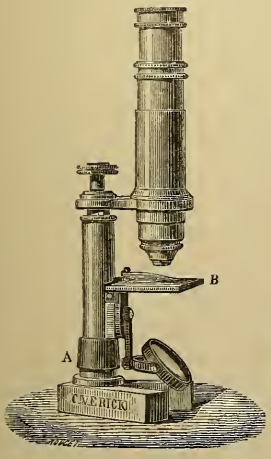
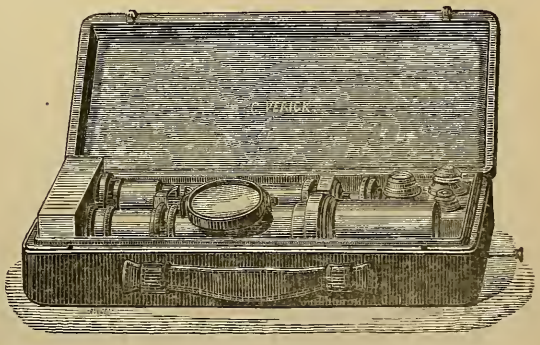


Fig. 47.



dients of reversing the body-tube in its sheath and setting the stage at right angles, but also by making the two legs of the base close

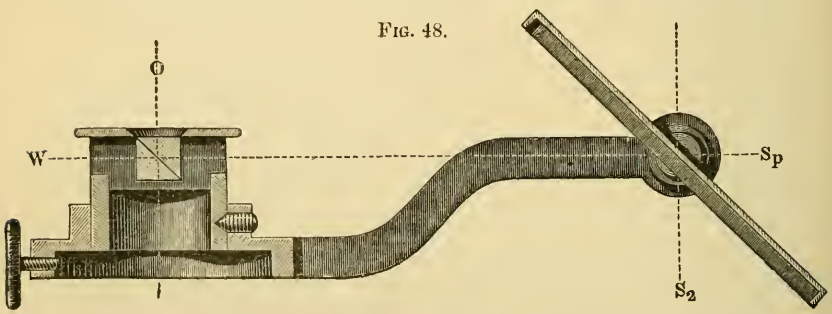
together, as in a pair of compasses. It then packs into a box 20 cm. by 10 cm. and 5 cm. deep.

The instrument was designed by M. C. Vérick, with the co-operation of Dr. L. Malassez.

Abbe's Camera Lucida.—We have already recorded the two or three paragraphs which have appeared as to this instrument,* and now add a figure of it taken from the 2nd edition of Dr. Dippel's work † (fig. 48).

The glass cube (consisting of two prisms, with an hypothenuse surface partly silvered, and leaving a small hole in the centre) is at W, the reflecting mirror at S*p*, the eye at O. The rays from the

Fig. 48.



paper come in the direction S_2, and are reflected first by the mirror, and a second time by the silvered prism to O, while the object is seen through the small hole in the silvered surface.

Herr E. Giltay ‡ writes of it with approval, both for low powers and also for high powers when tinted glasses are interposed to reduce the brightness of the drawing-surface, as described by Dr. Dippel, *ante*, p. 119, an improvement which Herr Giltay claims the credit of suggesting.

The rest of the article is devoted to what is described in the heading "as an improvement applicable to cameras in general," which is simply the very old expedient of introducing suitable lenses between the eye and the paper, but which the author writes of as if it were a new and important discovery now made by him for the first time! The following observations on the theoretical reasons for the benefit obtained by the lenses may be quoted.

Those who are accustomed to use the Microscope allow the accommodation of the eye to remain nearly quiescent. Just for this reason one can bear for so long a time without fatigue work apparently so trying to the eyes. With the camera, however, one is naturally obliged to accommodate the eye to the drawing-surface. In ordinary binocular vision drawing does not present so many difficulties to normal eyes, because, first, the paper is held at a convenient distance before the eyes, and, secondly, the required accommodation is guided and assisted

* See this Journal, ii. (1882) pp. 261, 593, *ante* p. 119.
† 'Das Mikroskop,' 2nd ed., 1882, pp. 631–2 (1 fig.).
‡ Bot. Centralbl., xiii. (1883) pp. 419–22.

by the convergence of the visual axes. It is quite different in drawing with the camera. If it is desired to avoid the inconvenient elevation of the drawing-surface, accommodation is necessary for the distance of this surface, and such accommodation is not assisted by a convergence of the visual axes. Many persons are therefore not able, without great fatigue, to accommodate their eye sufficiently to see the pencil clearly. This consideration suggests the remedy. If the observer is emmetropic (or normal-sighted), it is only necessary to insert a lens in the path of the rays proceeding from the paper to the eye, having a focus equal to the distance from the paper to the lens. The rays from the drawing-point are then changed into parallel pencils, and the eye sees the point with perfect distinctness, although accommodation is quiescent. If, however, the observer is ametropic (short-sighted or far-sighted), then a lens must be interposed which allows the rays proceeding from the paper to be directed after their exit from the lens to a surface situated at the distance of the *punctum remotum*.

The mode of choosing the appropriate spectacle glasses is then given in some detail, and these concluding remarks: "Man, as is well known, is in a high degree a slave of habit. When we begin to use the Microscope, it is difficult, on account of the reversal of the movements, to guide the object. If we are, however, once accustomed to it, and work occasionally with a dissecting lens, then the difficulty presents itself of effecting the movements which we formerly did a hundred times daily. The reversal of the movements has associated itself with the act of using the Microscope. It is the same also with the accommodation of the eye. When we begin to work with the Microscope it is tiring, probably for the most part on account of the effort of accommodation. One soon learns to relax the accommodation-muscles while working with the Microscope. When we have become adepts at this, and wish to draw by means of the camera, then the requisite accommodation again at first gives trouble. If finally an apparatus is fixed to the camera, by which no accommodation is needed, then it may happen that we cannot at once adapt ourselves to it, because in using the camera we had got accustomed to the exertion of accommodation. We soon, however, learn all this, only we must not too hastily consider a lens found by calculation as too strong, for this may occur through a false computation of the *punctum remotum*, or by not relaxing the accommodation in using the Microscope."

Hilgendorf's "Apparatus for Microscopical Geometrical Drawings."*—Dr. F. Hilgendorf describes an apparatus which is essentially a pantograph with the usual four arms, but in which the tracing point is replaced by a sight-vane. This is about 20 cm. above the arm, on which is a lens magnifying three to four times, and having crossed threads on its upper surface. If the outlines of the object are followed with the sight-vane, the pencil at the end of a prolongation of the opposite arm will produce an enlarged drawing of the outlines on the paper beneath it.

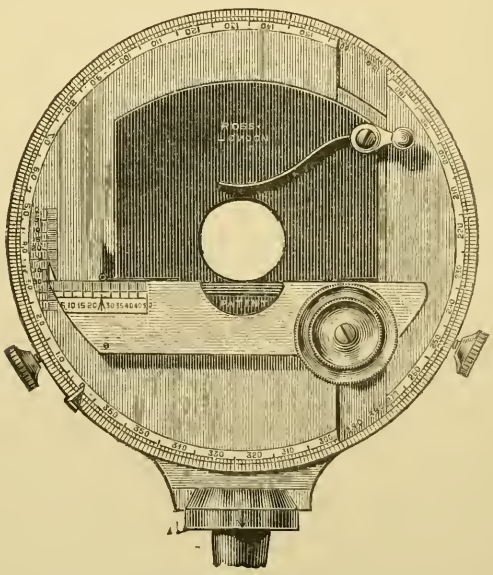
* SB. Gesell. Naturf. Freunde zu Berlin, 1882, pp. 58-60 (1 fig.). Zeitschr. f. Instrumentenk., ii. (1882) pp. 459-60 (1 fig.).

A pantograph for the compound Microscope was described in 1872 by Mr. I. Roberts.*

Wenham's Mechanical Stage.—This stage is shown in fig. 49, and was first described in connection with Wenham's "Universal Inclining and Rotating Microscope" (now termed "Wenham's Radial Microscope") at pp. 256–7 of the previous volume.

The stage rotates completely, and is a modification of that of Mr. Tolles, in which the rectangular motions are effected by two milled heads acting on *one* vertical axis on the surface and entirely within

Fig. 49.



the circumference.† It is attached to the limb of the Microscope on the Zentmayer system, that is, by a conical axis that passes through the socket of the swinging tail-piece and through the limb, being secured at the back by a clamp-nut; it can thus be easily removed, or may be replaced by a glass or other form of stage, &c. The rotating plate is of German silver; a circular rackwork is applied beneath, which is turned by a milled-head pinion; this pinion is fitted so that it can be disconnected from the rackwork by a slight downward pressure; the rotation can then be more rapidly made by hand. The graduations are near the edge of the rotating plate, the index-pointer is therefore in a fixed position, which is convenient for reading

* Mon. Micr. Journ., viii. (1872) pp. 1–2 (1 pl.).

† See the descriptions of similar stages, this Journal, i. (1881) pp. 116–7 (figs. 9 and 10), p. 300 (fig. 46), and for the mechanism of the rectangular movements see specially pp. 944–6 (figs. 221–3).

the angle. "Finders" are also engraved. The milled-heads on the edge are for centering the rotation on the optic axis. A simple and effective plan has been adopted of applying the iris-diaphragm, hemispherical immersion-condenser, or Wenham's semi-disk illuminator beneath the stage, where they are held by a small projecting peg and a spring latchet.

Altmann's "Abend-Condenser." *—Dr. R. Altmann has designed a condenser ("Evening Condenser"), which consists of a convex hemispherical lens of short focus with a disk of ground glass over it, and one of light-blue beneath it. The lens and disks fit into a tube similar to that used for the ordinary (German) cylinder-diaphragms.

Heating Apparatus.†—Thoulet describes a new method of heating objects upon the stage. He has constructed a small "stove" or chamber, to rest upon the stage, and to contain the object and the thermometer. It consists of a glass tube fitting into a copper cylinder which rests upon a disk of copper, furnished with lateral prolongations, which can be heated by a gas jet. The whole is insulated by resting upon a disk of cork. The temperature of the chamber can be raised by heating the prolongations of copper, and lowered by introducing a current of fresh air through a small tube fixed in the side. Very exact measurements can be taken with this simple apparatus, which is well adapted for determining the temperature of the disappearance of bubbles in liquid inclusions, for studying the formation of crystals at various temperatures, or for other micro-chemical investigations.

Abbe's Test-plate.—Dr. C. Zeiss has now issued directions for using this test-plate, which, notwithstanding that the subject was fully dealt with at p. 120, may, we think, be usefully reproduced here (with a few verbal alterations in the original text):—

"This test-plate is intended for the examination of objectives with reference to their corrections for spherical and chromatic aberration, and for estimating the thickness of the cover-glass for which the spherical aberration is best corrected.

The test-plate consists of a series of cover-glasses, ranging in thickness from 0·09 mm. to 0·24 mm., silvered on the under surface, and cemented side by side on a slide, the thickness of each being marked on the silver film. Groups of parallel lines are cut through the films, and these are so coarsely ruled, that they are easily resolved by the lowest powers, yet from the extreme thinness of the silver they also form a very delicate test for objectives of even the highest power and widest aperture.

To examine an objective of large aperture, the disks must be focussed in succession, observing in each case the quality of the image in the centre of the field, and the variation produced by using alternately central and very oblique illumination. When the objective is perfectly corrected for *spherical aberration* for the particular thickness

* Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1881, pp. 219–24.

† Bull. Soc. Mineral. France. Cf. Amer. Natural., xvii. (1883) p. 76.

of cover-glass under examination, the outlines of the lines in the centre of the field will be perfectly sharp by oblique illumination, and without any nebulous doubling or indistinctness of the minute irregularities of the edges. If, after exactly adjusting the objective for oblique light, central illumination is used, no alteration of the focus should be necessary to show the outlines with equal sharpness.

If an objective fulfils these conditions with any one of the disks, it is free from spherical aberration when used with cover-glasses of that thickness. On the other hand, if every disk shows nebulous doubling, or an indistinct appearance of the edges of the lines, with oblique illumination, or if the objective requires a different focal adjustment to get equal sharpness with central as with oblique light, then the spherical correction of the objective is more or less imperfect.

Nebulous doubling with oblique illumination indicates over-correction of the marginal zone, indistinctness of the edges without marked nebulosity indicates under-correction of this zone; an alteration of the focus for oblique and central illumination (that is, a difference of plane between the image in the peripheral and central portions of the objective), points to an absence of concurrent action of the separate zones, which may be due to either an average under- or over-correction or to irregularity in the convergence of the rays.

The test of *chromatic correction* is based on the character of the colour bands which are visible by oblique illumination. With good correction the edges of the lines in the centre of the field should show only narrow colour bands in the complementary colours of the secondary spectrum, namely on one side yellow-green to apple-green, and on the other violet to rose. The more perfect the correction of the spherical aberration, the clearer this colour band appears.

To obtain obliquity of illumination extending to the marginal zone of the objective, and a rapid interchange from oblique to central light, Abbe's illuminating apparatus is very efficient, as it is only necessary to move the diaphragm in use nearer to or further from the axis by the rack and pinion provided for the purpose. For the examination of ordinary immersion objectives, the apertures of which are, as a rule, greater than 180° in air (1·00 N.A.), and those homogeneous-immersion objectives which considerably exceed this, it will be necessary to bring the under surface of the test-plate into contact with the upper lens of the illuminator by means of a drop of water, glycerine, or oil. In ordinary cases the change from central to oblique light may be easily effected by the concave mirror, but with immersion lenses of large aperture it is impossible to reach the marginal zone by this method, and the best effect has to be searched for after each alteration of the direction of the mirror.

For the examination of objectives of smaller aperture (less than 40–50°), we may obtain all the necessary data for the estimation of the spherical and chromatic corrections by placing the concave mirror so far laterally, that its edge is nearly in the line of the optic axis, the incident cone of rays then only filling one-half of the aperture of the objective, by which means the sharpness of the outlines and the

character of the colour bands can be easily estimated. Differences in the thickness of the cover-glass within the ordinary limits are scarcely noticeable with such objectives.

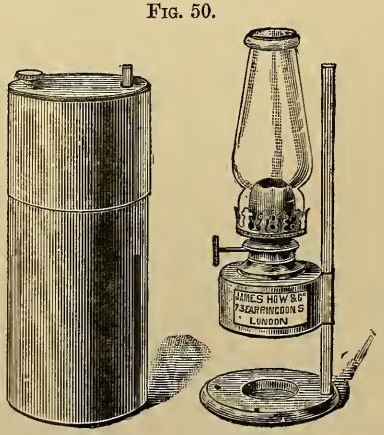
It is of fundamental importance in employing the test-plate to have brilliant illumination and to use an eye-piece of high power. With oblique illumination, the light must always be thrown perpendicularly to the direction of the lines.

When from practice the eye has learnt to recognize the finer differences in the quality of the outlines of the images, this method of investigation gives very trustworthy results. Differences in the thickness of cover-glasses of 0·01 or 0·02 mm. can be recognized with objectives of 2 or 3 mm. focus.

The quality of the image outside the axis is not dependent on spherical and chromatic correction in the strict sense of the term. Indistinctness of the outlines towards the borders of the field of view arises, as a rule, from unequal magnification of the different zones of the objective: colour bands in the peripheral portion (with good colour-correction in the middle) are always caused by unequal magnification of the different coloured images. Imperfections of this kind, improperly called 'curvature of the field,' are shown to a greater or less extent in the best objectives, when their aperture is considerable."

How and Co.'s Pocket Lamp.—The feature of this lamp (fig. 50) is its portability, having been constructed for microscopists who are in the habit of exhibiting at soirées, &c. It fits into a cylindrical tin case which is small enough to be carried without inconvenience in the coat-pocket. When charged with sufficient oil to burn for about 3½ hours it weighs less than 12 oz. As the foot is small, the pillar upon which the lamp slides has been made square, so that the centre of gravity is less likely to be disturbed. The lamp can be elevated so that the flame is 8 inches above the table, but if greater height is required, an additional two inches may be gained by standing the lamp upon the lid of the tin case and fixing it by means of a screw provided for the purpose.

Fig. 50.



Drawings and Paintings from the Microscope.*—The best series of coloured drawings of microscopical objects that have been seen within the memory of the present generation of microscopists, were those drawn and exhibited by Mr. E. T. Draper at the April

* Science-Gossip, 1882, pp. 1–3, 74, 203.]

Conversazione of the Society (Vol. II. (1882) p. 444). Mr. Draper has during the last year published several articles on the subject (giving hints from practical experience of the best methods of procedure), which, in the main, are not susceptible of abstract, but from which we take the following:—

The effect of a microscopical painting is greatly enhanced by its being drawn within a circle surrounded by a black margin forming a square. A circle $3\frac{3}{4}$ inches gives the best effect and approaches nearest the impression made upon the mind by a field with a B eye piece. A brass gauge should be kept for marking the circle and square.

The Wollaston camera lucida is to be preferred. The neutral tint reflector reverses the image, which renders it more difficult to fill in the drawing afterwards.

No drawings can be greatly advanced by the camera lucida. The latter can be used for quickly and accurately fixing and drawing the salient points, but any attempt at elaborate detail will end in confusion, and useful as it is in the earliest steps, it should be discarded as soon as possible.

The colours should be dry cakes. Moist colours in tins soon become contaminated. Everything should be of the first quality—the Indian-ink of superlative excellence. "All the colours should be prepared, and the tints mixed (to use the words of Opie) with brains."

In a later article the author "appends an experience of some importance.

An object for drawing should be magnified to show all the parts necessary for its elucidation, in fact, to understand it as a whole; and, as a rule, it should occupy the entire field of vision. It sometimes, however, happens that many elongated preparations, as for instance, the tongue and appendages of a bee, or a double-stained section of a botanical specimen, cannot without reducing the magnifying power to a useless attenuation be included in a circle, as recommended in a former paper, except at the loss of considerable and important detail; in such cases the circle must be abandoned and the drawing made in parts, by shifting the position of the object until the whole is combined on the paper. This is attended with some difficulty in the management of the camera lucida, but can be overcome in the following manner:—Having an elongated object, which cannot be seen in its entirety in one field of view, the process is, to draw the outline and salient positions of one end, or half-making two prominent points on the paper corresponding with two places in the subject; these positions are easily remembered. The object is then moved by the stage adjustments, upwards or downwards, as the case may be, until the other portion is in the field. The marked points are coincided, by shifting the drawing block, and the remainder of the outlines finished; the minute details of the drawing, and painting, afterwards continued from the object itself. By this method, the camera lucida may be used without difficulty with four combined fields of vision, and the various parts of the object so fitted as to result in a drawing of considerable dimensions, perfectly true in its contours. Botanical sections and elongated parts of insects, under fairly high

powers, may thus be mapped out with all the details exhibited in their relation to each other."

Double Illumination for Insects Mounted without Pressure.—Mr. E. T. Draper in the same article says, "For good artistic work the importance of double illumination cannot be too urgently advocated. Many beautiful objects are often unappreciated from deficiency or inapplicability of the light used to exhibit them. It is never more exemplified than in the combined use of the paraboloid reflector and side speculum, with a class of objects lately introduced, of parts of insects mounted in fluid without pressure, avoiding the disturbance of the more delicate tissues. Many parts of such preparations are necessarily opaque, which is rather an advantage from an art point of view, as, by force of contrast, their density aids in giving a most beautiful appearance to the more transparent structures; nothing being crushed or distorted, all is *in situ*. These preparations immediately awaken the mind to the impossibility of properly seeing or revealing them by the ordinary reflected light from the mirror. The head and adjoining parts of the male wasp prepared in this way by Mr. Enoch is singularly fine, and a case in point; with the paraboloid beneath the stage, and the side speculum above, a combination of form and colour is seen, of surpassing beauty. The light from the speculum touches the opaque parts with reflections revealing the most exquisite tints of a metallic appearance, while the paraboloid beneath shows, in actual perspective, the wonderful parts beyond in all their natural colour, and bathed in light."

Professor R. Hitchcock also points out* that although insect preparations "mounted without pressure" are mounted as transparent, there will always be some parts which are more or less opaque, especially in the larger specimens, and he has found much benefit from the use of a condensing lens above, as for an opaque object, at the same time throwing in light from below. A specimen of *Cimex* mounted in balsam by the carbolic acid process affords a good illustration of the utility of this double illumination.

Behrens' Guide to Microscopical Researches in Botanical Laboratories.†—A collected summary of methods and processes in botanical microscopy is much wanted, the literature on the subject being more scattered than is the case with histological methods in zoology. The author of this book has largely contributed to meet this want by the compilation now published, though it is to be regretted that the descriptions of Microscopes and apparatus occupy so large a proportion of the work, the 4th and 5th sections—the *pièces de resistance* of the book—being limited to pp. 219–387.

There are five sections:—1. General Description of the Microscope (pp. 1–75). 2. Accessory Apparatus (pp. 76–129, Dissecting Microscope, Cameræ, Micrometers, Polarizers, Goniometers, and Microspectroscopes). 3. Preparation (pp. 130–218). 4. Microscopical Reagents (pp. 219–61); and 5. Microscopical Investigation of the

* Amer. Mon. Micr. Journ., iii. (1882) p. 219.

† Behrens, W., 'Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium.' xii. and 398 pp., 132 figs. and 2 plates. 8vo, Braunschweig, 1883.

Plant Substances (pp. 262–387). The first two sections contain little new or special information. The third deals with the preparation of objects; those not requiring to be cut, instruments for cutting, the method of making sections (free-hand, in pith and cork, and in imbedding masses), the further treatment of the sections (removing air, clearing, &c.), making preparations of fossil plants, mounting objects (including living organisms), with the various preserving media and varnishes, and directions for drawing. The fourth section gives descriptions of and directions for preparing Microscopical Reagents under 39 headings (19 inorganic and 20 organic), including iodine solutions, staining matters, and the various carmine solutions. The fifth section deals with the following substances:—Cellulose and its modifications, Starch, Dextrin, Mucilage, Gums, Inulin, Grape-sugar (Glucose), Cane-sugar (Saccharose), Albuminous Substances (Aleurone, Protoplasm), Chlorophyll, Colouring Matters of Flowers, Asparagin, Inorganic Constituents (Silica and Lime Salts), Glycoside, Tannin, Alkaloids, Fats, Ethereal Oils, Camphor, Resins, Phanerogamic Colouring Matters, and Cryptogamic Colouring Matters. The bibliography of each substance is placed first, followed by a description of the substance; and, lastly, the methods most suitable for its demonstration.

The book cannot fail to be useful to botanical microscopists, though there is still room for a more extended treatise.

'Micrographic Dictionary.'—A fourth edition of this well-known and useful guide to the microscopist is now completed, edited by Dr. Griffith, one of its original editors, with the assistance of the Rev. M. J. Berkeley and Professor T. Rupert Jones. It bears marks of revision to bring the contents down to date, the article on Angular Aperture in particular embodying the results of the revival of the discussion on aperture reported in the last volume but one of this Journal. The editor gives a succinct explanation of the true view of aperture, and appends to the very ingenious explanation of the effect of oblique light given in the previous editions the statement—"In this way we were wont to account for the action of large angles of aperture and oblique light in rendering visible the finer markings of objects," followed by a brief statement of the Abbe theory of microscopical vision.

In the Bibliography of the Aperture question appears an entry, "Wenham, Amer. Jn. Micros. 1881," which probably refers to something which was to have been.

Behrens, W.—Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium. (Guide to Microscopical Researches in the Botanical Laboratory.) xii. and 398 pp., 132 figs. and 2 pls.
8vo, Braunschweig, 1883.

Berkeley, M. J. See Griffith, J. W.

Blackburn, W.—On Dr. Carpenter's Address. [*Post.*]
Micr. News, III. (1883) pp. 29–32.

,, ,, The President's Address to the Manchester Microscopical Society.
[On some of the ways in which natural science has been promoted by the use of the Microscope, and the advantages derived from microscopical research in our social relations, as affecting our well-being.]
Micr. News, III. (1883) pp. 93–105.

BRADBURY, W.—The Achromatic Object-glass. XV., XVI.
Engl. Mech., XXXVII. (1883) pp. 3–4, 74–5 (4 figs.).

COOMBS, C. P.—Notes on the Exhibition of Magnified Objects.
Journ. Post. Micr. Soc., II. (1883) pp. 13–6 (1 fig.).

CUTTRISS' (T. & S. W.) Dynamo.
[Small machines for one 20-candle power Swan incandescent lamp.]
Micr. News, III. (1883) pp. 56–7.

DAVIS, G. E.—The Elements of Microscopy. II.
[Some of the properties of plates, prisms, and lenses.]
Micr. News, III. (1883) pp. 45–51.

„ „ Electric Illumination for the Microscope.
[Note on Mr. Payne's paper, *infra*, and circular of Mawson and Swan's incandescent lamps:—"If they had executed the order given to them in 1881, Mr. Stearn . . . . would probably have been second or third in the field." "We would prefer to have the trouble of cleaning and preparing the oil lamp rather than the overpowering fumes from three cells of a Grove's or Bunsen battery. The electric light for microscopic purposes is no doubt in some instances a good thing, but its conveniences need not be exaggerated."]
Micr. News, III. (1883) p. 56.

ENGELMANN, T. W.—Ueber die Zusammenstellung von Sonnenlicht, Gaslicht und des Licht von Edison's Lampe, vergleichend untersucht mit Hilfe der Bacterienmethode. (On the Comparison of Sunlight, Gaslight, and the light of Edison's lamp investigated by the Bacteria method.) [*Post.*]
Bot. Centralbl., XIII. (1883) pp. 214–5.

FASE, H. J.—On a portable Binocular Dissecting and Mounting Microscope. [*Post.*]
Journ. Quek. Micr. Club, I. (1883) pp. 109–11.

GEIKIE, A.—Outlines of Field-Geology. 3rd ed. xv. and 222 pp. and 66 figs. 8vo, London, 1882.
[Contains a chapter on "Microscopical Investigation," pp. 201–15, including the preparation of thin slices and the use of the Microscope. See also p. 30.]

„ „ Text-book of Geology. xi. and 971 pp. and 435 figs. 8vo, London, 1882.
[Contains the above chapter, "with alterations and additions," pp. 182–91. Also a section on Minute or Microscopic Characters of Rocks: (1) Microscopic Elements of Rocks, and (2) Microscopic Structure of Rocks. pp. 94–108 (8 figs.).]

GRIFFITH, J. W., & HENFREY, A.—The Micrographic Dictionary. 4th ed., by J. W. Griffith, M. J. Berkeley, and T. R. Jones. 2 vols. xlvi. and 829 pp., 818 figs. and 53 plates. 8vo, London, 1883.

H., E. A. C.—Magnifying measurements.
[Inquiring why with 1-in. objective and B eye-piece, said by the maker to magnify 76 times, the 1-100th in. divisions of the stage-micrometer only appear 1-3rd in. long, instead of 76-100ths or 3-4ths in.]
Sci.-Gossip (1883) p. 42.

HARDINGHAM, G. G.—Telescopes and Microscopes.
[Brief note on the question of antiquity.]
Knowledge, III. (1883) pp. 121–2.

HARDY, J. D.—On "The Chromatoscope": a method of illuminating crystals and similar objects by coloured light.
[Already published, *ante*, p. 126.]
Journ. Quek. Micr. Club, I. (1883) p. 108.

HENFREY, A. See Griffith, J. W.

HILGENDORF, F.—Apparat für mikroskopische geometrische Zeichnungen. (Apparatus for microscopical geometrical Drawings.) [*Supra*, p. 279.]
SB. Gesell. Naturf. Freunde zu Berlin, 1882, pp. 58–60 (1 fig.).

His's Drawing Apparatus.
[Vol. II. (1882) p. 402.]
Amer. Natural., XVII. (1883) pp. 227–9 (1 fig.).

Hitchcock, R.—Notes (1) to Subscribers as to punctual payment of subscriptions; (2) as to the change of management (publishers) of the Journal; and (3) on editorial perplexities.
Amer. Mon. Micr. Journ., IV. (1883) p. 12.

„ „ The American Postal Microscopical Club.
[Note as to the obligations of the members in regard to putting slides in the boxes, &c.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 14–15.

„ „ The Projecting Microscope for Class Demonstrations.
[General remarks, especially as to the desirability of opticians devising a better form, and as to the advantages to be obtained by it for purposes of instruction.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 15–16.

„ „ Correction-adjustment for Objectives.
[Discussion of the advantages with particular reference to Dr. L. Dippel's paper in 'Zeitschr. f. Instrumentenk.' "It may be said that the importance of correction-adjustment increases with dry objectives as the angular aperture increases." With reference to homogeneous-immersion objectives, he considers that "practically, the advantage of the collar-adjustment is quite illusory when the microscope is applied to the study of objects the structure of which is unknown."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 28–30.

„ „ Standard Sizes for Oculars and Sub-stages.
[Note on the Committee's Report, II. (1882) p. 595. "It is to be hoped that our American makers will adopt the same sizes."]
Amer. Mon. Micr. Journ., IV. (1883) pp. 35–6.

„ „ See Mendenhall, T. C.

Holman, D. S.—Projecting Microscope of peculiar design.
[Exhibition only.]
Proc. Acad. Nat. Sci. Philad., 1882, p. 359.

Johnson, G. J.—Photomicrography.
[Description of necessary apparatus, manipulation, &c.]
Micr. News, III. (1883) pp. 113–21 (2 figs.).

Jones, T. R. See Griffith, J. W.

Journal of the Royal Microscopical Society. Vol. II. 1882.
[Review.]
Journ. of Sci., V. (1883) pp. 108–110. See also p. 115.

Kitton, F.—Magnifying measurements.
[Reply to H., E. A. C., *supra*, that he must have made some mistake, either in the powers or in making his measurements. Also describes method of ascertaining the magnifying power by observing a scale with one eye.]
Sci.-Gossip (1883) pp. 66–7.

Langley, J. N. See Foster, M.

Loewenherz, L.—Zur Geschichte der Entwickelung der mechanischen Kunst. III. Die Feineintheilung von Kreisen. (On the History of the development of mechanical Art. III. The fine dividing of Circles.)
[Deals with the employment of Microscopes in the process.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 447–59 (7 figs.).

Malassez, L.—Sur les perfectionnements les plus récents apportés aux appareils hémochromométriques et sur deux nouveaux hémochromomètres. (On the most recent improvements in hæmochromometric apparatus and on two new hæmochromometers.)
Trav. Lab. d'Histol. Coll. France, 1882, pp. 105–60 (2 figs.).

Malley, A. C.—Micro-photography, including a description of the wet collodion and gelatino-bromide processes, together with the best methods of mounting and preparing microscopic objects for micro-photography. viii. and 154 pp., 28 figs., and 4 micro-photographs. 8vo, London, 1883.

Mendenhall, T. C.—On the Fasoldt Stage Micrometer.
[Reply to the editor's comments on his paper (*ante*, p. 136), and disclaimer of any desire not to represent Prof. Rogers fairly; and rejoinder of the editor.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 17 and 18.

Miles, J. L. W.—Circular on Dr. Carpenter's Address at the Montreal Meeting of the Amer. Assoc. Adv. Sci. [Vol. II. (1882) pp. 698 and 854]; and his reasons for closing the Aperture controversy [Ibid. p. 864]. 2 pp. 4to, Manchester, Nov. 1882.

Moore, A. Y.—A New 1-6th in. Objective.
[Commendatory of a homogeneous-immersion objective by Spencer and disapproving of wide-angled objectives being made with non-adjustable mounts.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 2–3.

" " The Podura Scale. [*Post.*]
The Microscope, II. (1883) pp. 186–8 (3 figs.).

Moss, R. J.—Micro-photographs of Bacteria [and Yeast-plant.—Exhibition.]
Ann. & Mag. Nat. Hist., XI. (1883) p. 216.

Munson, W. W.—A Country Doctor and his Microscope—Some of his early cases. I.
[Diagnosis of ovarian tumour by examination of fluid from abdomen of patient.]
The Microscope, II. (1883) p. 190.

Nelson, E. M.—Powell and Lealand's 1-25th in. homogeneous-immersion objective 1·40 (1·38) N.A. and fine adjustment to the substage [Vol. II. (1882) p. 554]. *Jour. Quek. Micr. Club*, I. (1883) pp. 142–3.

Newton's (H. J.) Developer for Dry Plates.
[Solution A. Washing soda, 500 grains; water, 10 oz. Solution B. Oxalic acid, 30 grains; pyrogallic acid, 20 grains; ammonium bromide, 10 grains; water, 10 oz. Mix equal parts of A and B.]
Amer. Mon. Micr. Journ., IV. (1883) p. 37, from *Photographic Times*.

Paul, F. T.—Inaugural Address as President of the Liverpool Microscopical Society (in part). *Micr. News*, III. (1883) pp. 85–6.

Payne, J. B.—Stearn's new form of Illumination for the Microscope.
[Sep. repr. of short description given at a Meeting of the Newcastle Chemical Society, 28th Dec. 1882. *Post.*]

Peletan, J.—Editorial Address. *Journ. de Microgr.*, VII. (1883) pp. 3–4.

Price, H. C.—How to make Pictures. 2nd ed. 72 pp. New York, 1882.
["Easy Lessons for the Amateur Photographer," with a short chapter on photography with the Microscope.]

"Prismatique."—Object-glass working. IV.
Engl. Mech., XXXVI. (1883) p. 514 (3 figs.).

Rogers-Bond Comparator.
[Description of Prof. W. A. Rogers' instrument for comparing standards of length.]
New York 'Mechanics,' III. (1883) pp. 57–61 (8 figs.).

Ryder, J.—Upon the Embryology of Fishes. Also upon a Compressorium of special design for study of the above. [Title only.]
Proc. Acad. Nat. Sci. Philad., 1882, p. 360.

Schrauer, L.—"New" form of nose-piece for facilitating the changing of objectives.
[Appears to be identical with Parkes', III. (1880) p. 1048.]
Amer. Mon. Micr. Journ., IV. (1883) p. 17.

Slack, H. J.—Pleasant Hours with the Microscope.
[Observations by polarised light.]
Knowledge, III. (1883) pp. 190–1.

Stodder, C.—The Podura Scale.

[Approval of article by Prof. R. Hitchcock, *ante* p. 135. "Dr. Woodward's theory is the correct one of the structure of the Podura Scale. The spines have no tangible existence."]

Amer. Mon. Micr. Journ., IV. (1883) p. 4.

Van Brunt, C.—*Amphipleura pellucida.*

["Resolved by Mr. Spencer with an unfinished 1-10th in. objective, a flour-barrel being used for a table, and the mirror bar of the Microscope being so loose that it had to be propped up with a stick. Daylight was used for illumination."]

Amer. Mon. Micr. Journ., IV. (1883) p. 39.

White, T. C.—Photo-micrography.

[Report of demonstration at Quekett Microscopical Club. *Post.*]

Engl. Mech., XXXVI. (1883) p. 492 (1 fig.).

" " The President's Address. (Quekett Microscopical Club.)

[Traces "some of the successive steps by which we have attained to our present position in the use of the Microscope."]

Journ. Quek. Micr. Club, I. (1883) pp. 112–24.

Whitson, J.—The Photography of Microscopic Sections.

[Contains description of the method adopted for taking photo-micrographs of Sections of Adeno-sarcoma of Mamma.]

Sep. Repr. *Glasgow Med. Journ.*, 1883, March, 5 pp. (1 photomicr.).

β. Collecting, Mounting and Examining Objects, &c.

Collecting Small Organisms.*—In order to procure small organisms for microscopical examination, living in their natural habitat, Professor K. Möbius fixes some glass slides in a piece of wood in which cuts, a few millimetres deep and of the thickness of the slides, had been made with a saw. The wood was nailed to a pole attached to a landing-stage in Kiel harbour, in such a way that the wood with the slides was a few feet above the sea-bottom. For the examination of the organisms on the glass slides, they were removed from the wood, and immediately fixed in a cork, and floated in a glass vessel full of sea-water.

Upon such glass slides hydroid polyps, annelids, bryozoa, infusoria, rhizopoda, diatoms, &c., attach themselves.

In the aquarium slides may be similarly suspended from corks in order to have infusoria, rhizopoda, &c., for immediate examination.

Chloride of Gold and Cadmium for Nerve-Terminations.†—Prof. G. V. Ciaccio minutely describes a process for treating the terminations of the motor-nerve fibres in the striated muscles (of the torpedo) which is not Loewits', nor yet Ranvier's, but partly one and partly the other.

After detaching the muscles and stretching them on a glass plate their fibrous envelope is carefully removed. The anterior third, which contains nearly all the nerve-terminations, is cut off and again cut up into pieces of 1 mm. These are placed in fresh lemon-juice (filtered through blotting-paper), and left for five minutes. Then with bone forceps each piece is washed in distilled water, and placed in 4 c.cm. of a solution of chloride of gold and of cadmium (1 per cent.), in

* Zool. Anzeig., vi. (1883) p. 53.

† Journ. de Microgr., vii. (1883) pp. 38–41.

which they should lie for half an hour, protected from the light. Again taken out and washed, they are put in 50 cm. of distilled water, acidulated with 1 per cent. of formic acid, and kept in the dark for twelve hours, and then for as many exposed to sunlight. Next they are put in a small glass and wetted with formic acid, so as to cover them, and again kept in the dark for twenty-four hours. Finally, the acid is removed, and they are washed in distilled water, which is in its turn removed and replaced by Price's glycerine.

Thus treated the fibres are tinted in different colours, some in a more or less deep blue, others in an intense or light violet, and others, again, in a cinnabar red or dark reddish brown. The double chloride is, in the author's view, preferable to the use of chloride of gold, because the former is less uncertain in its action, and does not give rise to the disagreeable precipitates produced by the latter when it comes in contact with the "organized and nearly living parts." The method has been successfully used with the cornea of frogs, birds, and mice, and other parts rich in nerves.

Monobromide of Naphthaline for Histological Preparations.*—Dr. M. Flesch refers to the fact that this fluid has apparently not been used in histology, although it has proved to have important advantages for diatoms. Whilst he has not himself arrived at results of a special kind (on the contrary, in many cases which justified a hope of success the result was negative) yet he thinks it desirable to call attention to the medium as it is not improbable that in the case of objects in which everything is not revealed by staining, many parts may be seen better in monobromide of naphthaline than in other media.

The preparations must be very carefully dehydrated as the slightest trace of water produces cloudiness. They can be mounted either direct from absolute alcohol, or after being passed through oil of turpentine (creosote and oil of cloves are less suitable). For cementing, either wax or lac-varnish or thickened Venice turpentine.

Dr. Flesch suggests further experiments to determine whether or not monobromide of naphthaline improves the recognition of minute structures such as fine wrinkles in skin, small granulations, &c.

Sulphocyanides of Ammonium and Potassium as Histological Reagents.†—Prof. W. Stirling calls attention to the value of the sulphocyanides for revealing the presence and arrangement of the intranuclear plexus of fibrils in coloured and colourless blood-corpuscles. For this purpose a drop of a 10 per cent. solution of either agent is added to a drop of the blood of a newt or a frog. After a time the hæmoglobin becomes quite discoloured or removed, and remarkable changes take place in the nucleus; it swells up, becomes more distinct, and shows in its interior an exquisitely arranged intranuclear plexus of fibrils. This plexus can be stained with fuchsin or eosin, and kept for a long while.

The solutions are also admirable "dissociating" media for iso-

* Zool. Anzeig., v. (1882) pp. 555–6.
† Journ. Anat. and Physiol., xvii. (1883) p. 207–10.

lating epithelial cells. Small pieces of the tissue are placed in the solution for twenty-four or forty-eight hours. They may be stained afterwards with picrocarmine, but before doing so it is necessary to remove all traces of the sulphocyanide by steeping the tissue in water for a short time. The sulphocyanide causes a precipitation of the picric acid. The cells show very distinctly an intranuclear plexus of fibrils. What seems to happen is that the interfibrillar ground-substance of the nucleus swells up slightly, and so opens out the network of fibrils. In the liver of the newt and frog an intranuclear plexus of fibrils is also revealed by similar treatment.

The intranuclear plexus is also seen in non-striped and striped muscle and nerve, and in the thin cartilage of the sternum of the frog or newt. The fibres of the crystalline lens after twenty-four or forty-eight hours show a beaded appearance, some of the swellings being apparently due to the action of the reagent upon some chemical constituent of the lens fibres, and some perhaps to the swelling up of the cells on the fibres.

Preserving Insects, Crustacea, Worms, and small Vertebrates.*—Professor K. Möbius finds that convenient preparations of the different stages of development of insects can be made by putting eggs, young and old larvæ, pupæ, and imagos in a glass tube filled with spirit, and having a stopper of cotton wool, then placing them, according to their age, in a stoppered upright vessel filled with spirit, in the middle of which is a cylindrical glass, which presses the glass tube against the side of the upright vessel.

To make tape-worms, long nemertines, long annelids, and similar organisms satisfactorily visible, he rolls them spirally on a thick glass tube and then places them in an upright cylindrical vessel of spirit only a little wider than the tube. The worm is fastened to the top and bottom of the latter by means of a fine white-silk thread, or, better still, with isinglass.†

Very instructive sections of small mammalia, birds, frogs, fishes, and crustacea, can be made by attaching them to a board, dorsally, ventrally, or laterally, according to the section, and imbedding them in a freezing mixture, until they are quite frozen through. Then cut them with a broad-bladed knife, or saw if necessary, attach to the section-plane a glass plate, and lay the preparation in strong spirit until all viscera become so hardened that they retain their place. Then the preparation can be cleaned and mounted. The author's museum contains preparations mounted in this way of fishes in which the spinal marrow, brain, olfactory nerve, swimming bladder, &c., are very beautifully shown. In a longitudinal section of *Turdus merula*, the form of the air-sac is distinguishable within the breast-bone.

Mounting the Proboscis of a Fly.‡—Mr. T. W. Lofthouse directs the fly to be killed by putting it into a bottle containing a little carbolic acid that has been rendered fluid by the addition of a drop or

* Zool. Anzeig., vi. (1883) pp. 52–3.
† Cf. Prof. E. Selenka, ibid. v. (1882) p. 169.
‡ Microscopical News, iii. (1883) pp. 21–2 (1 fig.).

two of water; no more water should be used than is necessary. Cut off the head and place it in a small porcelain saucer, and cover with a little of the acid, which must be changed about every other day for say a week, or until it ceases to become coloured. The tongue will then, in most cases, be found to be protruded, or may be forced out by slightly pressing the head.

Expanding.—To expand the tongue, it should be placed in the centre of a glass slip, and put upon a piece of wood about 5 in. by $1\frac{1}{4}$ in., into one end of which a piece of wire has been inserted and bent over to form a clip, the centre being covered with a circle of white paper to form a light background. A piece of glass about 1 in. by $1\frac{1}{2}$ in., to be used as a presser, is placed upon the glass and under the spring, and is kept apart from the slip by several folds of paper about the thickness altogether of the fly's head. The head, with eyes uppermost, and the tongue protruded towards the right hand, is then placed in a drop of acid under the edge of the presser, and held there; and, if necessary, the tongue forced to protrude further by a slight pressure of the forefinger of the left hand. While in this position, the expander, a piece of glass 1 in. by $\frac{3}{4}$ in., to the under side of which a small cover-glass has been fastened by brown cement, and having a piece of paper by which to hold it gummed to the top, is used to force the lobes of the tongue backwards—that is, towards the left hand, and downwards, into the required position. The palpi, which will usually be found lying against the head, may then be arranged by means of a stiff bristle, and the head laid aside for three or four days to set.

Mounting.—After cutting away the head, transfer the tongue, which must be kept the same side up, to a drop of fresh acid on the centre of a clean glass slip. This may be done by pushing it on to the end of a quill which has been bent a little at the end, to form a kind of spoon. Apply balsam at the right-hand side of the cover-glass, and drain off the acid by holding a piece of blotting-paper to the opposite edge. If any cloudiness appears, warm the slide a little. A light clip may then be put on, and the slide put aside to harden. No needles should be used in any part of the process.

Preserving and Staining Protozoa.*—Dr. H. Blanc whilst recognizing that the methods of preserving Protozoa are already numerous, describes one which he has employed for a year and a half, and which has given satisfactory results, without any loss of the colour in Canada balsam.

Certes and Landsberg use osmic acid; Korschelt, chromic or osmic acid; Kleinenberg's picro-sulphuric acid (also used by Entz) is employed by the author, compounded as follows:—Concentrated picric acid, 100 vols.; sulphuric acid, 2 vols.; distilled water, 600 vols. This solution may be used as it is for preserving the larvæ of Echinodermata, Medusæ, and sponges; but for Rhizopoda and Infusoria, add a little 1 per cent. acetic acid, two or three drops to 15 cc. of liquid. The object of this addition is to bring out

* Zool. Anzeig., vi. (1883) pp. 22–3.

sharply the nuclei and the nucleoli, and if not in excess, it never injures the protoplasm. Thus prepared, the liquid is preferable to osmic acid, because the organisms being perfectly killed or fixed, it allows of a surer and more regular colouring, if care is taken to choose a suitable colouring matter.

Dr. Blanc does not fix the animals until they are covered with the cover-glass, a plan also recommended by Korschelt. This method is very advantageous and easy; for, in spite of Landsberg's opinion, the organisms are quite as well impregnated by the acid solution as if in a watch-glass.

The length of time during which the objects should be subjected to the action of the solution, varies according to the size or number of individuals under the same cover-glass; but it is not until they have all taken a yellowish colour that the preparation can be continued with success. The picro-sulphuric acid is then removed by 80 per cent. alcohol, renewed until the yellow colour has completely disappeared, then 96 per cent. alcohol is substituted, and finally absolute alcohol. The organisms being hardened, their staining may be proceeded with. For that purpose an alcoholic solution of safranin is preferable; 5 gr. of safranin are dissolved in 15 cc. of absolute alcohol, and having stood for some days, the solution is filtered and diluted with half its volume of distilled water. This solution is preferable to picrocarmine, because the colouring is more quickly effected and may be regulated according as it is desired to bring out the protoplasm or the nuclei.

After the object has been sufficiently stained it is washed in 80 per cent. alcohol, renewed until no clouds of colour appear, when the 80 per cent. alcohol is replaced by absolute alcohol and the latter by oil of cloves. Safranin being soluble in alcohol a certain quantity of the colouring matter will naturally be removed by the washing with 80 per cent. alcohol; but by substituting more or less rapidly the oil of cloves for the alcohol, the colour may be regulated; that is, a more or less intense colouring of the protoplasm around the nucleus can be obtained.

The method can also be recommended for marine nematodes, whose thick chitine is not an obstacle to colouring by the alcoholic solution of safranin.*

Preservative for Fungi.†—Three years ago M. E. Banning invented what she thinks a very good and cheap liquid for the preservation of fungi, composed of the following ingredients: 4½ oz. of common salt, 5 oz. of pulverized alum, and 1 quart of white wine vinegar. Mix thoroughly, and keep in a wide-mouthed glass jar. Brush off any dirt that clings to the fungus, and drop the freshly-gathered plant into the liquid.

A large jar of plants that were collected in the summer of 1879 are now in a perfect state of preservation. They have diminished

* Dr. C. O. Whitman (Amer. Nat., xvii. (1883) p. 458) says that "the process of decoloration is not entirely arrested by the application of clove oil, contrary to Blanc's assertion, hence it should be replaced by Canada balsam as early as possible."

† Bull. Torrey Bot. Club, ix. (1882) p. 153.

somewhat in size, but their structure is preserved, and the larvæ are effectually destroyed. The liquid often gets filled with sediment and floating particles, to free it from which it should be poured off, strained through a piece of thin muslin, and returned to the plants.

Osmic Acid for Microscopical Investigations.*—Dr. T. B. Redding gives directions for preparing the proper solutions of osmic acid for microscopic use :—Take a glass bottle, with a ground-glass stopper, and cover it thoroughly with black paper, so as to exclude all light, covering the exposed parts of the stopper in the same manner. If you have the ordinary capsule containing $\frac{1}{32}$ oz., and require a 1 per cent. solution, put 3 oz. of distilled water into the bottle and then drop the capsule into it and shake violently, so as to break the capsule, or, if that does not succeed, break with a clean glass rod. In a few hours the acid will have dissolved, and the fluid will be ready for use. For removing from the bottle, use a dropping-tube kept especially for that purpose.

Dr. Redding also describes the method of using osmic acid for staining purposes. (1) By immersing the object in the fluid; (2) by exposing it to the vapour of the solution; and (3) a third method, that of injection, which is a modification of the first. The objects he used were the nerve-fibres, nerve-plates, blood-corpuscles, epithelium, protoplasmic and other elements connected with or adjacent to the blood-vessels of the frog, toad, kitten, &c., which were stained by first injecting the vessels, through the aorta, immediately after death, with a very dilute solution of osmic acid in water and glycerine, equal parts. Twenty to thirty drops of the 1 per cent. solution should be used to the ounce of water and glycerine, and the injection followed in two or three hours after with an injection of Beale's blue, or with carmine jelly fluid, reduced to a delicate rose-tint by excess of water and gelatine. The preparations may be further differentiated with other stains.

The vapour method changes the elements less and admits of further staining processes more readily than any other method. Log-wood and eosin are the best stains to use after treating with osmic acid. Either will give good results with most tissues. In using carmine, it is best to stain the tissues before exposing to the vapour. Sometimes the vapour will attack the carmine and nearly obliterate it.

For infusoria, algæ, &c., fixed and stained with osmic acid, the following is found to act well, both as a stain and a preservative: Picrocarmine, 1 part; distilled water, 1 part; glycerine, 1 part; apply by allowing a drop to run under the cover-glass on the slide. As a hardening agent, osmic acid is valuable for very delicate structures, such as brain, nerve, and embryonic tissues; especially for soft tissues which are to be cut into sections. For this purpose the following method is best:—Take of a 1 per cent. solution of osmic acid, 1 part; a mixture of equal quantities of water and glycerine, 2 parts; of a 1 per cent. solution of chromic acid, 2 parts; alcohol, $\frac{1}{2}$ part; mix. The specimen to be hardened should be small. After remaining in the solution a few days or hours, according to size,

* Proc. Amer. Soc. Micr., 5th Annual Meeting, 1882, pp. 183-6.

character, &c., the process is finished by transferring the specimens to 25 per cent., 50 per cent., 75 per cent., and absolute alcohol successively.

Where a tissue has become too deeply stained with osmic acid, it may be bleached by putting it into a weak aqueous solution of ferrocyanide of potassium, care being taken afterwards to thoroughly wash the section in water. The cyanide of potassium will effect the same purpose, but must be used with care.

Infusoria, algæ, and other objects, killed, fixed, and stained with osmic acid, have been mounted nearly a year, and show no signs of change as yet. It is also especially valuable in examining the white blood-corpuscles (as it instantly kills and fixes the pseudopodia), and in bringing out clearly glandular, nerve, and fatty structures, and tissues. Sudorific, sebaceous, and other glands are better brought out by its use than in any other method that the author has used. A specimen of the meibomian glands of the upper eyelid is exceptionally fine and beautiful. It is also very valuable in differentiating all structures affected by fatty degeneration, particularly in the early stage of this regressive action.

Carbolic Acid in Mounting.*—Mr. W. J. Pow points out that contrary to the general opinion, carbolic acid is not an acid, and has no acid properties whatever. Chemically speaking it is an alcohol, belonging to a series of alcohols quite different in composition from common ethyl-alcohol, and from wood-spirit, which is closely related to common alcohol. But carbolic acid is, nevertheless, a true alcohol, and for this reason it can be frequently substituted for ethyl-alcohol in microscopical work. One great advantage which it has over the latter is found in the readiness with which it penetrates a specimen, and mixes with the fluids used in mounting, such as water, glycerine, and Canada balsam. Another is, that it does not harden tissues and make them stiff. For this reason insects, or parts of insects, can be preserved indefinitely in carbolic acid, in a fit condition to be mounted at any time. The more delicate parts are made quite transparent by long soaking in the solution, but this is no detriment to them.

The acid used for mounting should be the strongest solution, having just enough water in it to keep it fluid at ordinary temperatures. To use it for mounting, it is only necessary to drop the specimen into the acid, and in a few moments transfer it to the prepared cell containing the medium in which it is to be mounted. Suppose it is desired to mount a mosquito, or a plant-louse, or any minute insect which requires no preliminary treatment, drop the insect into the acid, and in a few minutes it will be seen that the fluid has thoroughly penetrated the body. Then it is quite immaterial whether the specimen is to be mounted in water, or glycerine, or balsam, for carbolic acid will mix as readily with one as with the other. Fill the cell with the medium to be used, place the specimen on a clean slide, and take up the excess of fluid with blotting-paper, then transfer it to the cell, and arrange the parts with needles, when the cover-glass can be applied.

* Amer. Mon. Micr. Journ., iv. (1883) pp. 8–9.

When insects require any preliminary treatment to make them transparent, such as soda solution, the solution should be thoroughly removed by washing with water, after which the specimens should be taken out one by one, the superfluous water removed with blotting-paper, and then thrown into the carbolic acid.

The author has used carbolic acid instead of alcohol in mounting stained sections of wood, with excellent results, and it is much cheaper than alcohol.

Injection Methods.*—Dr. H. Griesbach makes some observations on this subject, with reference more particularly to his investigations † on the vascular system of the Acephalæ.

Whilst injection-masses which are fluid when cold are the simpler and easier in use, those which are fluid only when warmed are indispensable for the coarser vessels.

For the observation of vessels with the naked eye or a lens, glycerine simply may be used with the addition of a bright colouring matter.

Another mass, fluid when cold, can be made by heating equal parts of white and yellow wax, and dissolving in oil of turpentine, and, after cooling, the solution is mixed with olive or rapeseed oil in which sulphate of lead has been ground up. The result is a whitish-yellow syrupy fluid, very useful for many injections. Sulphate of barium or iodide of lead may be substituted for the sulphate of lead. By the addition of spermaceti to the solution in oil of turpentine the mass can be made thinner. The sulphates and the iodide are not dissolved, but are in a very finely divided condition.

If an injected preparation has to be afterwards cut, it should be injected with gelatine (fluid when cold), with or without glycerine. The gelatine can be coloured with all kinds of colouring matters. The canula cannot be too small. With this mass the author has obtained beautiful dry preparations prepared as follows. The injected foot of *Anodonta* or *Unio*, after being laid for a short time in alcohol, was placed in oil of turpentine, and later in a mixture of the same and paraffin and exposed to the air. It dries without any shrinking, and sections can be made with chloroform.

For gelatine masses fluid when warm, chloride of uranium can be used, which dissolves in water, and by which the gelatine gets a glistening yellow colour. The most effective masses are some of the aniline colouring matters, especially the glistening ones, such as Bieberich scarlet, crocein, tropæolin, &c.

The author then discusses the relative advantages of injecting the living or dead animal, and expresses a decided opinion in favour of the former contrary to that of Sabatier. Whilst with the latter he has obtained tolerable injections of the lacunæ of the foot of *Mytilus edulis*, it would be hopeless to attempt to fill the lacunæ of the foot of *Anodonta* or *Unio* after death. Further details are given as to the injection of the lacunæ in these subjects.

* Arch. f. Mikr. Anat., xxi. (1882) pp. 824–7.

† See this Journal, ii. (1882) p. 605.

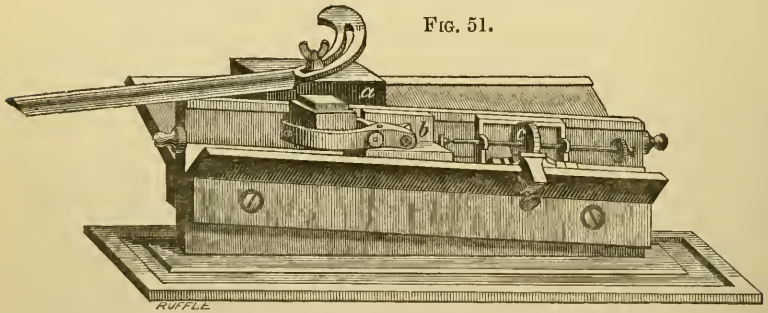
Ceresine and Vaseline for Imbedding.*—Dr. M. Schulgin prefers instead of pure paraffin a mixture of that substance with ceresine and vaseline. The paraffin should melt at 55°, and to it add at discretion ceresine, the density of which is considerably greater than that of the former. Ceresine is like wax, but harder and tougher, properties which make it very valuable as an imbedding substance. The mixture is tolerably hard, but that does not matter, as it is tough at the same time. If a soft mass is wanted vaseline must be added at discretion. Its special property is that it is not greasy but soft and tough.

Paul's Modification of Williams' Freezing Microtome.†—Mr. F. A. Paul modifies this instrument by making the inner cylinder movable while the outer one is fixed. The inner cylinder, carrying the frozen mass, is attached to the short arm of a lever below, the long arm of which is actuated by a fine screw, which extends above the upper plate, and is fitted not with a milled head but with a toothed wheel. The frame to which the knife is attached works on a pivot in the upper plate, and rests by two rounded legs on the plate as it moves over it. A hinge in the frame allows the razor to be lifted clear of the imbedded material on the return movement. An adjustable catch on the razor-frame turns the toothed wheel and its screw through a given part of a revolution, so as to elevate the mass by any desired amount at each cut of the knife.

Thoma's Sliding Microtome (Imbedding Methods).—Dr. R. Thoma, Extraordinary Professor of Pathological Anatomy at the University of Heidelberg, has been good enough to write us the following description (in English) of his instrument, which has acquired considerable reputation both on the Continent and in England.‡ He adds also remarks on its use.

The microtome (fig. 51) consists of a stand of cast-iron, on

Fig. 51.



Thoma's Microtome.—*a*, carrier for the knife; *b*, carrier for the object; *c*, micrometer-screw for fine adjustment.

which slide two carriers. The large knife is attached to one of these *a*, which slides horizontally. The second *b* holds the specimen to

* Zool. Anzeig., vi. (1883) pp. 21–2.

† Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 283–4.

‡ A brief description without figs. appeared in Virchow's Archiv, lxxxiv. (1881) pp. 189–91.

be cut. This second carrier moves on an inclined surface, so as to raise the specimen as required.

This, with a few modifications, is the general character of all sliding microtomes; but hitherto the carriers were constructed to slide with two even surfaces between two even planes of the stand, which intersect at a given angle, with the consequence that all show more or less imperfect results, owing to the fact that it is impossible to obtain sufficiently exact plane surfaces. The inconveniences appear in small irregularities of the movement of the carriers, and the consequent impossibility of making sections as thin as with an experienced hand.

This induced Prof. Thoma to enter upon a consideration of the geometrical and mechanical difficulties to be surmounted. The question to be solved was, how many points at least of a body sliding between two planes must touch the latter for this body to be perfectly steady in its position. It will be found that five points are sufficient, and that a carrier on five points, between two plane surfaces, will slide without difficulty between these planes, even if they are not absolutely geometrical planes, or the angle which they include is not everywhere the same. Such a carrier will always take exactly the same course; and, in consequence, a knife attached to it will cut a series of perfectly parallel sections through an object which is successively raised to a higher plane after each cut. The working of the instrument will therefore be far superior to any microtome with large sliding surfaces which nowhere exactly fit the sliding surfaces of the stand. This indicates the desirability of constructing the carrier for the object on five points also.

The construction resulting from these principles is simple and practical, but it is necessary to take into consideration the centres of gravity of the different sliding bodies. This, however, complicates the matter but very little. We replace the two sliding surfaces of each carrier by five slightly prominent points, and they will then move with exactness on any combination of two planes, not differing too much from geometrically plane surfaces. One condition only must be fulfilled, namely, that the five points are so chosen as to support steadily the centre of gravity of the carriers, including their accessory parts—namely the knife and object. Fig. 52 gives a more precise idea of the details of construction.

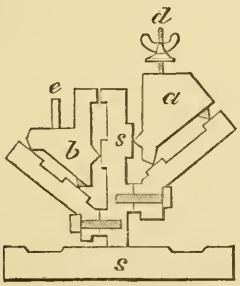
In the figure the lower surfaces of the carrier *a*, which supports the knife show three prominences, which gives the geometrical projection of the five points. Within the limits of the figure these points could not be drawn exactly as they are in the instrument itself. In reality, they appear only as small prominences upon three narrow ridges on the sliding surfaces of the stand. This arrangement was desirable to facilitate the action of the oil with which the sliding surfaces are to be covered. Two of the ridges form together parts of the oblique plane, and the third corresponds to the vertical sliding plane. The same arrangement is found in the carrier *b*, which supports the clamp in which the object is placed.

By this mode of construction the carriers will move gently and regularly even if the sliding surfaces of the stand are not perfect

geometrical planes. It is still, however, of course desirable that as much exactness as possible should be obtained in these planes, as their irregularities cannot fail to affect the sections, especially as they are, in fact, multiplied in the latter. Prof. Thoma highly commends Herr Jung, of Heidelberg, who makes the microtomes under his instructions, for the great exactness which he has obtained.*

As the efficiency of a newly-constructed instrument is best judged of by practical experience of its capabilities, Prof. Thoma (besides stating generally that it has been found that any one can produce sections of great delicacy with this microtome without previous practice), gives the following facts: — Specimens which are well hardened will allow of sections of 3 to 4 sq. cm. surface and 0·015 to 0·010 mm. thickness. In exceptional cases, pieces of so large a surface may even be cut of 0·005 mm. thickness. If the section is smaller (for instance, 1 cm. square), the thickness can be reduced considerably—say to 0·005 mm., or, in extreme cases, to half that. It is not, however, all tissues and objects that will admit of sections of such delicacy. Well-hardened liver may generally be cut to 0·015 mm., this being about the diameter of the hardened cell. Occasionally, however, in this tissue, sections of 0·010 mm. can be obtained. Lymphatic glands and brain may be cut to 0·010 or 0·075 mm.; embryonic tissues, well imbedded, usually admit sections of 0·005 and 0·003 mm. In some cases even sections of 0·002 mm. thickness can be obtained. These numbers refer to the largest size of the microtome, and to serial sections. The two smaller sizes will give sections of the same delicacy, but comparatively smaller in extent of surface. The length of the sliding surfaces of the large instrument is 40 cm., and the edge of the knife is 23 cm. In the medium size these dimensions are 27 and 16 cm., and in the smallest about 21 and 11 cm.

Fig. 52.



Transverse Section of the Microtome.—*ss*, stand; *a*, carrier for the knife; *b*, carrier for the object; *d*, screw to attach the knife; *e*, axis supporting the clamp for the object.

Prof. Thoma also adds some practical remarks on the use of the microtome, and the necessary previous preparation of the specimens, it being his opinion that further progress in section-cutting is to be

* Prof. Thoma remarks that at a time when already a number of his microtomes were in use, an instrument entirely different in its general appearance, but yet constructed on similar principles, appeared in America—the microtome of Mr. Fletcher (Boston 'Medical and Surgical Journal,' 1880). The knife-carrier slides on five points on the bottom of a large basin filled with alcohol. This microtome shows such eminently different qualities to the one explained here, that the independence of the invention is on both sides very evident. The value of the principle, however, is at the same time demonstrated by the relative good results which have been obtained by this American machine. Its limit as regards the thinness of the sections appears to be 0·0004 in.

expected from the perfecting and development of the technical methods of preparing, hardening, soaking, and imbedding the tissues. Personally, he feels sure that any tissue (excluding bone and teeth before decalcification) may be prepared so as to be cut to any degree of delicacy down to 0·002 mm. The microtome will work with sufficient exactness to permit this, but hitherto there are only a few tissues which we can prepare so perfectly as to admit sections of such extreme minuteness. The following are the points to which he most especially wishes to draw attention :—

Sliding microtomes are in general constructed for cutting sections of tissues previously hardened in alcohol, picric acid, chromic salts, and other agents. Fresh tissues are decidedly better cut by freezing microtomes—for instance, on the simple and practical instrument of Hughes and Lewis. The addition of a freezing apparatus to a thoroughly exact sliding microtome is neither advisable nor necessary. The differences of temperature produced in different parts of the instrument would be apt to interfere with the perfect planeness of the sliding surfaces; whilst, on the other hand, section-cutting with frozen tissues is so simple and easy with the ordinary freezing apparatus that any further complication in the way of a sliding support of the knife is superfluous.

In cutting, the microtome is to be placed before the operator as in fig. 51, with the sliding surfaces abundantly covered with oil (bone-oil), and the knife moistened with alcohol. In many cases, it will be sufficient to simply place the hardened specimen between the arms of the clamp attached to the carrier *b* (fig. 51). The clamp should then be fixed in such a position that the specimen is as near as possible to the knife-carrier. The knife will generally have to be adjusted so as to bring the whole length of its blade into action. Very hard specimens are frequently cut with less difficulty by placing the knife more obliquely in regard to the long diameter of the instrument.

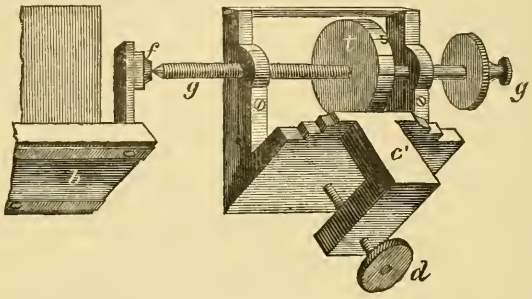
The inclination of the oblique plane upon which the carrier *b* slides is 1 : 20, and, consequently, the section will be 1-20th mm. thick if the carrier is moved 1 mm. on the oblique plane. A scale in millimetres with a vernier allows the operations to be exactly regulated. The vernier will be found sufficient for sections of 0·015 mm. Sections of greater delicacy should always be made by using the micrometer-screw (*c*, fig. 51), which was designed to obtain the utmost exactitude in the management of the carrier *b*. Fig. 53 shows it on a larger scale.

The carrier *c'* slides on the same oblique plane as the carrier *b* which holds the specimen. In all positions of the latter, it is therefore possible to bring the point of the micrometer-screw *g g* close to a small polished plate of agate *f*, which is fixed to the carrier *b*. In this position, *c'* should be firmly screwed to the stand of the microtome by *d*, and every revolution of the micrometer-screw *g g* will then push the carrier *b* 0·3 mm. The periphery of the drum *t*, which is firmly attached to the screw *g g*, is divided into 15 equal parts; and consequently each division marks a thickness of section

equivalent to 0·001 mm. The finest sections hitherto produced reach only 0·002 mm. thickness.

Since the first microtome was taken into use, a series of minor improvements have been made. One of them consists in a clamp

Fig. 53.

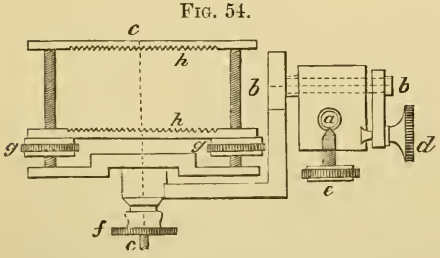


Micrometer-screw for delicate sections.

(fig. 54) for holding the object which can be turned round three axes, and admits therefore of a very easy adjustment of the object in regard to the knife. It was devised to meet the desire for occasionally turning the object between two successive series of sections.

The two metal plates *h h* form the jaws of the clamp. Between them is placed the cork which carries the specimen, and the latter is fixed by turning the screws *g g*. The three axes are *a*, *bb*, and *cc*, and round these the clamp can be turned, *a* being vertical, and *bb* and *cc* horizontal. In all positions these three axes can be made immovable by the screws *d*, *e*, *f*. The axis *a* is formed by the vertical rod *e* (fig. 52), on the carrier supporting the clamp and object. The details of the construction are partly new, and are very solid and durable. Their arrangement is such as to admit of a division of the circles in which the clamp can be turned.

Fig. 54.



Clamp to be turned in three directions (as seen from above).

Another improvement has been devised by Mr. Jung. This is an arrangement which regulates the movement of the micrometer-screw, in such a way, that after a given number of divisions of the drum, a spring registers to the ear and finger of the manipulator the number of micromillimetres which the object has been raised. These intervals can be varied within certain limits by a simple adjustment comparable to a vernier. The construction of this apparatus is

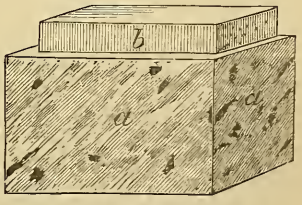
decidedly very elegant, but the divisions of the drum of the micrometer-screw are so large and easily visible, even to weak eyes, as in Prof. Thoma's opinion to make such complications useful only for very special conditions.

Other improvements by different manipulators relate merely to secondary points, and do not touch the essential principles of construction.

Taking the hardened specimen directly between the arms of the clamp is generally not advisable, as by such a proceeding sections of great delicacy cannot be obtained. It should be fastened with gum arabic to the even surface of a square piece of cork, and the latter inserted in the clamp. In this way compression is avoided. A concentrated solution of the gum is placed on the surface of the cork, and the hardened specimen is watered a few moments to drive away the alcohol from its surface, and it can then be adjusted on the gummed cork and plunged again into alcohol. The latter will in a few hours harden the specimen as well as the gum, and we obtain a preparation like fig. 55.

These methods are sufficient for the great majority of cases, and the different animal and vegetable tissues can be cut into sections varying according to their structure between 0·030 and 0·005 mm. Sometimes, however, and always if sections of extreme delicacy are required, it is necessary to use more complicated procedure. For example, the normal human lung hardened in alcohol and prepared as above, will perhaps admit of sections of 0·030 mm.; a human lung affected by acute pneumonia may perhaps be cut to 0·015 mm., but if greater delicacy is required, the tissue must be soaked in gum arabic, or other substance which admits of a more solid hardening. In this case human lung will allow of sections down to 0·007 mm. Objects of very small dimensions, like embryos, small animals, leaves of plants, &c., must be imbedded in suitable masses, which may be adapted to a cork as above before they are cut.

Fig. 55.



Hardened specimen *b* adapted to cork *a*.

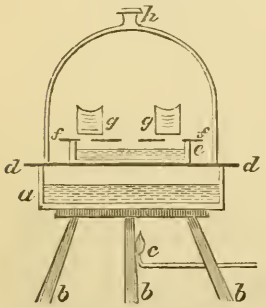
Imbedding Methods.—Prof. Thoma adds to his description of his microtome some remarks on the imbedding methods more generally used. The method of treating tissues with gum arabic, first brought into use by Rindfleisch and Ranvier, is now very generally known and practised. The same may be said of the method of cutting sections between two pieces of elder pith or hardened liver, &c. These in certain conditions are very useful and simple, but other methods of imbedding of more recent date give sections of the utmost perfection and unsurpassed delicacy.

The method of imbedding in emulsions containing fat and albumen, originated with Bunge, and was subsequently modified by Calberla and Ruge. The following is very nearly the formula of the

latter:—The albumen and yolk of several hen's eggs is placed in a porcelain mortar and well stirred, until it forms a thin yellow fluid, a result generally obtained in a few minutes. This fluid is subsequently passed through thin linen in order to remove the remaining membranaceous fragments. The specimen previously hardened in alcohol is then fixed by pins in a paper box, and covered with the fluid. The preparation cannot, however, be immersed directly in alcohol for the purpose of hardening. It must be first hardened by alcohol steam, taking care never to raise the temperature of the steam above 30° C. For this purpose Prof. Thoma uses a simple apparatus represented in fig. 56.

A shallow water-bath *a* stands on an iron tripod *b b b*, and is heated by a small flame *c*. The water-bath is covered by a thin plate *d d*. Upon this plate is a small glass vessel *e*, filled with common alcohol and covered with a perforated disk of tin *f f*. On this disk are placed the paper boxes *g g*, containing the specimens and the imbedding fluid. The latter and the alcohol vessel are again separated from the external air by a glass cover *h*. This apparatus slightly heated will harden the imbedding masses within a few days, after which time they are removed and subsequently fully hardened in a bottle containing ordinary alcohol. The latter process determines the degree of consistence of the imbedding mass. It can be made extremely hard by repeated use of strong alcohol. After a few trials it will be easy to find the convenient degree of consistence for each specimen.

Fig. 56.



Apparatus for hardening egg-emulsion.

If the temperature of the alcohol steam is more elevated, it will be found that the imbedding mass, instead of shrinking, will appear to increase in volume, innumerable air-bubbles developing in the emulsion. This can be easily avoided by using lower temperatures. Another danger, however, exists in the holes which the pins make in the walls of the paper boxes. The emulsion before hardening is so very liquid, that it will pass through the smallest opening; this renders it necessary not to withdraw any of the pins from the sides of the paper box, and to use boxes without any openings. It will be found that this mass adapts itself perfectly to all surfaces of the specimens without penetrating into their interior structure, and that it can be cut admirably at all thicknesses down to 0·003 mm. Another very agreeable quality results from the fact that the newly prepared emulsion will adapt itself readily to hardened pieces. This enables us to spread out fine membranes on pieces of the hardened imbedding mass, and subsequently to imbed both in the way just described.

After this praise of the egg-emulsion, it will be just to mention a property which is occasionally disagreeable. It cannot be easily detached from the sections, and we have no means of dissolving it in media which do not injure the objects. The mass also colours in all

the staining fluids generally used, and therefore becomes very visible in the preparations. The latter inconvenience should in all cases be avoided by colouring the specimen *in toto* before imbedding. For this purpose the fluids of Grenacher,* and especially alum-carmine, may be recommended. The imbedding mass remains nearly absolutely colourless if the specimen, after staining and before imbedding, is hardened again in alcohol.

Very elegant results may also be obtained by an imbedding mass originally invented by Duval, and recently much improved by Merkel and Schiefferdecker.† This is collodion, or, preferably, a solution of so-called *celloidin*. If this substance cannot in general be cut to such extreme delicacy as the albuminous mass just described, it has a great advantage in being extremely pellucid. The original communication of the last-named author is easily accessible, so that Prof. Thoma considers it is superfluous to give a detailed account of it, but adds a few remarks on his own experiences with it.

According to the formula of Schiefferdecker, the imbedding fluid consists of a concentrated solution of celloidin in a mixture of equal parts of absolute alcohol and ether. The specimen is soaked successively in absolute alcohol and ether, and in the imbedding fluid. This requires at least several days. After this time the imbedding proper may be undertaken, and for this we have the choice of two methods.

The even surface of a cork is covered with a thick solution of celloidin, so as to form by evaporation a strong collodion membrane on the cork. Upon this is put the specimen, covered layer by layer with fresh quantities of the solution of celloidin, each being allowed to dry only partially. When the object is thoroughly covered, we immerse it in alcohol of 0·842 sp. gr. In twenty-four hours the whole is ready for cutting.

The other method makes use of little paper boxes for the imbedding. The specimen, soaked in celloidin solution, is fixed in the box by pins, and the box filled with celloidin. The preparation is then placed on a flat piece of glass and covered with a glass cover, which does not exactly fit the glass plate. In a few days the ether will have evaporated gently and slowly from the imbedding mass, and the latter will shrink a little. If necessary, further celloidin solution can be poured in the paper box, to fill it again. It is only necessary to moisten the surface of the first mass with a drop of ether, in order to allow of a perfect junction between the old and the new layers. The preparation is again exposed to slow evaporation below the glass cover, and a few days later the imbedding mass will be consolidated to an opaline body, whose consistency can well be compared to that of the albumen of a boiled egg. The walls of the paper box can now be removed, and the imbedding mass placed in very dilute alcohol, which will in a few days produce a proper degree of consistency to admit of cutting.

This method differs in some degree from that which Schiefferdecker gives for imbedding in paper boxes. As other observers have re-

* Arch. f. Mikr. Anat., xvi. (1879) p. 465.

† Arch. f. Anat. u. Physiol. (Anat. Abtheil.) 1882.

marked, his method frequently gives rise to a great number of air-bubbles in the imbedding mass. Consequent upon the altered manipulations of Prof. Thoma, we have to adapt the imbedded specimen to a cork for the purpose of cutting. This may be done in the following way. The even surface of the cork is covered by a thick layer of celloidin solution. This is allowed to dry up perfectly, so as to produce a hard membrane of celloidin. This is again covered with further celloidin solution. In the meantime the lower surface of the imbedding mass is cut even, and washed with absolute alcohol, and subsequently moistened with a drop of ether. This moist surface is adapted to the stratum of liquid celloidin on the cork, and exposed for a few minutes to the open air. After this the whole is placed in dilute alcohol, which in a few hours will unite the imbedding-mass solidly with the cork.

In a great number of cases it may be regarded as a great advantage of the celloidin that it penetrates the tissues thoroughly, and yet remains pellucid, so as to be more or less invisible in the specimen. This quality can be made use of in another direction for the purpose of soaking specimens which are too brittle to be cut after hardening alone. We may make use of celloidin in a similar way to the gum arabic mentioned above. The minute normal and pathological anatomy of the lung in particular will derive great advantage from such a proceeding. Indeed, we are not able to get a perfect idea of the changes produced by pneumonia if we do not by this method or by the following (with paraffin) prevent the loss of a great part of the exuded substances which in this disease lie loose in the alveolar cavities. The study also of micro-organisms in the lung will derive great benefit from the celloidin method, and it will be very welcome to many to know that the tissues imbedded in celloidin may be stained with the different fluids, ammonium-carmine, alum-carmine, borax-carmine, hæmatoxylin, anilin colours, and various others. The reaction of acids and alkalies, particularly acetic acid and solution of potash, is, moreover, not interfered with. And, further, we are able to colour the object before imbedding with all staining fluids which are not soluble, or only little soluble, in alcohol and ether.

After staining and cutting, the sections may be mounted in glycerine and various other fluids. Mounting in Canada balsam requires, however, some precautions on account of the chemical character of the celloidin. Absolute alcohol and oil of cloves should be avoided and replaced by alcohol of 96 per cent., and by oleum origani. This is, at least the advice of Schiefferdecker, and Professor Thoma has had no occasion to be dissatisfied with the result.

The efforts of Bütschli and Blochmann * have given us another splendid imbedding mass, paraffin dissolved in chloroform, which admits of sections of the highest delicacy. Bütschli was able to cut in this imbedding substance small specimens down to 0·002 mm. This method seems particularly adapted to researches in embryology and zoology, where hitherto imbedding masses formed of paraffin and turpentine have been frequently used.

* Biol. Centralbl., i. (1881) pp. 591–2. See this Journal, ii. (1882) p. 708.

Usually it appears advisable to stain the specimens *in toto* before imbedding in paraffin and chloroform, and for this purpose Grenacher's alum-carmine and borax-carmine are very highly to be recommended. The long-known ammonium-carmine is also occasionally useful.

Dr. M. Schulgin,* in order to obviate the inconvenience that the same portion of the knife has always to be used, has had a knife of a somewhat different construction made (but which he does not explain). The advantage of this is that it can be moved along its whole length, so that different portions can be used for cutting.

Professor R. Kossmann writes,† "Many to whom the turning back of the micrometer-screw of the microtome is an annoying delay, will be thankful to me for pointing out to them that in two or three seconds it can be turned back its whole length by using a kind of fiddlebow, such as is used for drilling holes. The loop of the bow-string (made of strong silk cord, waxed or rosined) is passed round the smooth neck of the screw, and the bow is moved alternately to the left with stretched, and to the right with slackened cord."

Fixing Sections.‡—Dr. J. Frenzel considers that the method of Giesbrecht for fixing the preparation with shellac upon the slide has the disadvantage of preventing the colouring of the sections, so that the entire object must be coloured. To obviate this often serious drawback, he employs the following method:—Dissolve guttapercha in chloroform and benzine, and filter the solution when it has settled until it is clear and almost colourless. With this solution, which must not be too thin, and must only spread slowly over the glass, smear the middle of a carefully-cleaned slide, and after it is dry, lay the section on it. (1) If the preparations have been imbedded in paraffin or a mixture of paraffin (e.g. four parts of paraffin and one of vaseline), absolute alcohol must be dropped upon them, in order to make them unroll and lie flat. After this they must be exposed to a temperature of from 35° to 50° C. for about five to ten minutes, in order to make the guttapercha viscous; and after exposure to the air for five to ten minutes, they must be put in a vessel with warm absolute alcohol (from 40° to 50° C.), to extract the paraffin. This requires five to fifteen minutes. Alcohol must be used freely, as it is not capable of dissolving much paraffin. When the alcohol is saturated it can be filtered cold, and used as before. The preparation is now put in 70 per cent. alcohol and gradually into water, and coloured at discretion. After the washing it is put in absolute alcohol, in order to withdraw the water; and, finally, oil of cloves is dropped upon it to soften the guttapercha; and it is finally mounted in balsam or some similar substance. (2) If the object has been imbedded in celloidin, as is now very often done, the sections are also laid on the layer of guttapercha, and benzine or chloroform dropped on them, by which means they stick fast. After they are dried, they are coloured, and finally put in absolute alcohol, and treated with oil of cloves (in drops), by which the celloidin is dissolved.

* Zool. Anzeig., vi. (1883) p. 21. † Ibid. ‡ Ibid., pp. 51–2.

The latter is scarcely necessary for objects that are not very delicate. The colouring succeeds perfectly in this way also.

Mounting Sections in Series.*—Prof. R. Kossmann considers that the paraffin method of Dr. Giesbrecht † is far the best for the preparation of sections in series, and especially indispensable when it is desired to retain *in situ* in the completed preparation detached portions (such as embryos in the ovary). The soaking of the object in chloroform, suggested by Giesbrecht, before placing it in paraffin, is especially necessary when dealing with chitinous membranes, which are very impermeable. Prof. Kossmann has found that the complete evaporation of the chloroform is a very tedious operation; bubbles of chloroform are easily left behind in the cavities of the prepared paraffin mass; and he therefore uses an air-bath instead of the less easily managed water-bath. It is made of sheet-iron with glass sliding doors, and two small horizontal glass shelves. Two openings in the top are for a thermometer and a Kemp–Bunsen gas-regulator for low temperatures. Beneath is a Bunsen burner connected with the regulator. This air-bath is heated day and night, and a constant temperature of 50° C. kept up. On one of the shelves stands the glass vessel with the paraffin mixture. Two kinds of paraffin are used, of 56° and 36° melting power. It is *very* important, for the success of the sections, to have a mixture corresponding to the temperature of the room. A temperature of 18° requires a mixture of 48° melting point. On hot summer days the hardest kinds of paraffin must be used pure.

The object, soaked with chloroform, is put into the paraffin bath (without any mixing with chloroform), and left there from a few hours to two or three days, according to its size; after which it is quite uniformly penetrated with paraffin, even in the smallest cavities. The paraffin mass is poured into moulds of thick tinfoil.

The second shelf of the air-bath is for the slides. The shellac layer on the slide is brushed over with creosote, according to the old method of Giesbrecht, and Prof. Kossmann finds that no running together of the creosote takes place if the brush is lightly used and the slide slightly warmed. The creosote evaporates in a few minutes in the air-bath whilst the next slide is being filled, without danger of over-heating, and without being exposed to dust or damp deposits.

Creese's Turntable.—The speciality of this form of turntable (the design of Mr. E. J. E. Creese) is the method by which it is driven. A strong steel spring coil, on being wound up, starts a clockwork train of three cog-wheels. The sleeve of the table is made narrow and grooved, the whole train being arranged to secure 750 revolutions of the table for one of the driving-wheel, thus providing sufficient power to admit of speed-regulating appliances. The spring is wound from the top of the box, underneath the hand-rest, and the rotation of the table is stopped by pressing down a small brass bead placed at the side of the box. The slide

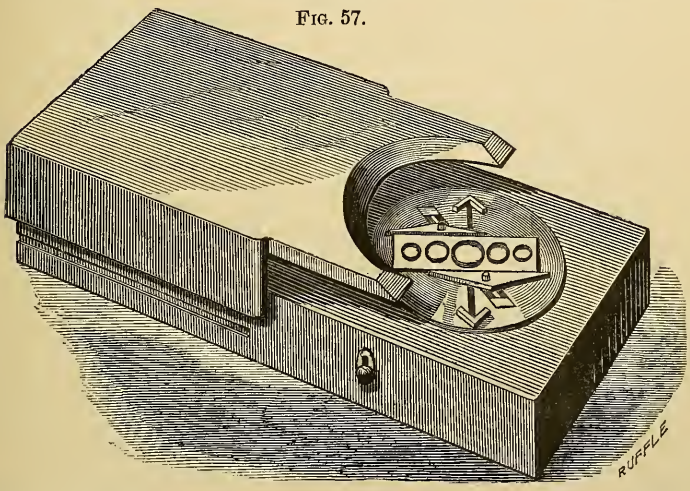
* Zool. Anzeig., vi. (1883) pp. 19–21.

† See this Journal, i. (1881) p. 953, ii. (1882) p. 888.

is clipped at the corners by two jaws, working in slots (as in Cox's and other forms), and is thus accurately centered. One of these jaws is fixed and the other attached underneath to the sleeve of the table by a spiral spring and drawn back upon the slide. Provision is made for re-touching slides the circles upon which are not truly central by two brass clips traversing oblique slots cut in the table, and being held in by brass split springs. Several cells can also be placed upon one glass slip.

A new form of hand-rest, sliding along two grooves cut in the

FIG. 57.



sides of the box, can be conveniently adjusted for every class of work. Underneath this rest, and at the opposite end of the box, is a sliding lid, which when drawn back opens a compartment sufficiently large to contain the key, brass clips, small bottles, brushes, rings, cover-glasses, slips, &c.

B., M. A.—Breakage of Slides in the Mail.

[Inquiring for a method for safe transmission, and note by the Ed., "We hear no complaints about it in England," &c.]

Amer. Mon. Micr. Journ., IV. (1883) p. 38.

BALKWILL'S (F. P.) Slides of 50 Foraminifera.

Journ. Post. Micr. Soc., II. (1883) pp. 60–1.

BANNING, M. E.—Preservative for Fungi. [*Supra*, p. 294.]

Bull. Torrey Bot. Club, IX. (1882) p. 153.

CAMERON, P.—On a simple method of mounting objects for microscopical examination.

[The object is to avoid the formation of two distinct collections, the dissection on the ordinary slide being kept in one place and the insect in another. The author, therefore, uses very fine cardboard in pieces 9 lines by 6. A hole 2½ to 3 lines across is punched at one end in the centre and 1½ to 2 lines from the edge. The lower side is closed by a cover-glass, and the object mounted in balsam. The dissection can now be placed alongside the insect in the collection. The author also explains his method of preserving larvæ by the roasting process, also Aphidæ.]

Proc. Nat. Hist. Soc. Glasgow, V. (1882) pp. 4–7, 65.

Chadwick, H. C.—The Marine Dredge, as an implement for collecting material for microscopical and zoological study.

[Describes the construction of a small net-dredge for the larger forms of crustacea, molluscs, and polyzoa.]

Micr. News, III. (1883) pp. 41–5 (3 figs.).

„ „ On mounting Insects in Balsam without pressure. [*Post.*]

Micr. News, III. (1883) pp. 105–6 (1 fig.).

Ciaccio, G. V.—Note sur la terminaison des fibres nerveuses motrices dans les muscles striés de la torpille traités par le chlorure d'or et de cadmium. (Note on the termination of the motor nerve fibres in the striated muscles of the *Torpedo* treated with chloride of gold and cadmium.) [*Supra*, p. 290.]

Journ. de Microgr., VII. (1883) pp. 38–41.

Clark, J. W.—Preliminary Note on the Bacillus of Tuberculosis (Koch).

[Contains remarks on Staining.]

Nature, XXVII. (1883) p. 492.

Cole, A. C.—Studies in Microscopical Science.

No. 39 (pp. 257–8). Text.—Notes on the Comparative Anatomy of the Alimentary Canal. Slide.—V. T. Section Tongue of Dog, injected carmine, stained logwood. Double Plate.—Human Tongue, Papillæ, Glands, &c.

No. 40 (pp. 259–60).—*Ficus elastica*. T. S. upper portion of Leaf with Cystolith, stained logwood. Plate × 333·3.

No. 41 (pp. 261–4).—The Alimentary Canal. The Oral Cavity. V. S. Tongue of Dog. Circumvallate Papilla, stained logwood. Plate × 65.

No. 42 (pp. 265–70).—White Syenite. Lairg, Sutherland. Plate × 25.

No. 43 (pp. 271–4). Text.—The Alimentary Canal. The Tongue. Slide and Plate (× 65) of T. S. Œsophagus of Dog, injected and stained logwood.

No. 44 (pp. 275–80).—*Ribes nigrum* (the Black Currant). T. S. of Stem, showing the formation of Cork, stained in carmine and aniline green. Plate × 500.

No. 45 (pp. 281–4). Text.—The Alimentary Canal. The Pharynx; and description of plate and slide accompanying No. 43. Slide of T. S. Cardiac end of Stomach of Dog, stained logwood. Plate.—The Stomach. Cardiac Glands of Bat (× 420); Dog (× 350 and 450).

No. 46 (pp. 285–6).—*Pinus sylvestris*. The Scotch Fir. T. S. of Leaf, stained logwood. Plate × 500.

No. 47 (pp. 287–92). Text.—The Alimentary Canal. The Stomach. Slide and Plate of V. S. Stomach of Dog. Pyloric end, × 65.

Coppock's directions for staining and preparing sputum to show *Bacillus tuberculosis*.

[Cf. II. (1882) p. 896.] *Micr. News*, III. (1883) pp. 121–2.

Davis, G. E.—Preparing Illustrations of Microscopical Objects.

[Describes the danger of woodcuts from photographs, unless the engraver is somewhat acquainted with his subject, illustrated with two figs. showing the different renderings of the same object.]

Micr. News, III. (1883) pp. 52–4 (2 figs.).

Dippel, L.—Nachtrag zu E. Boecker's Mikrotom. (Supplement to description of E. Boecker's Microtome.)

[Brief supplementary note to previous description in *Bot. Centralbl.*, XII. (1882) p. 212 in commendation, &c., and introducing an outline fig. of it.]

Bot. Centralbl., XIII. (1883) pp. 249–50 (1 fig.).

„ „ Das neue Mikrotom von Dr. C. Zeiss. (The new Microtome of Dr. C. Zeiss.) [Vol. I. (1881) p. 699.]

Bot. Centralbl., XIII. (1883) pp. 388–9 (1 fig.).

Griesbach, H.—Die Azofarbstoffe als Tinktionsmittel für menschliche und thierische Gewebe. (The nitrogenous colouring substances as staining media for human and animal tissues.) [*Post.*]

Arch. f. Mikr. Anat., XXII. (1883) pp. 132–42.

Groves, J. W.—Hudson's Extract of Soap for Cleaning Slides.

[Hurts nothing, and cleans the slides to perfection. If they are put in a solution of the extract and left for a few days, the balsam, cement, &c., will clean off beautifully.]

Journ. Quek. Micr. Club, I. (1883) p. 144.

HEITZMANN, C.—Microscopical Morphology of the Animal Body in Health and Disease. 847 pp. and 380 figs. 8vo, New York, 1883.

HITCHCOCK, R.—Photography and its value in Microscopical investigations. [*Post.*] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 33–4.

HUNT, J. G.—Upon Special Methods of Preparation and Mounting of Microscopical Objects. [*Title only.*] *Proc. Acad. Nat. Sci. Philad.*, 1882, p. 360.

HURST, G. H.—The Microscopical Structure of Rocks. III. Crystals. IV. Minerals. *Field Naturalist*, I. (1883) pp. 198–202.

INGPEN, J. E.—*Volvox* mounted in a dilute solution of iodide of potassium. *Journ. Quek. Micr. Club*, I. (1883) pp. 135–6.

JEAFFRESON, J. B.—The Microscope in Medicine. *Journ. Post. Micr. Soc.*, II. (1883) pp. 16–27.

KEY, A., & RETZIUS, G.—Ueber die Anwendung der Gefrierungsmethode in der histologischen Technik. (On the use of the freezing method in Histological Technics.) [*Post.*] *Retzius's Biolog. Untersuch.*, II. (1882) pp. 150–3.

KINGSLEY, J. S.—The Naturalist's Assistant: a Handbook for the Collector and Student. 228 pp. 8vo, Boston, 1882.

[Contains directions for collecting and for using the Microscope, and general laboratory work.]

LAKE, H. C.—Pond Life in Midwinter.

[Records living objects found in January.]

Sci.-Gossip, 1883, pp. 63–4.

MASON'S (R. G.) Anatomical Objects.

[Sections illustrating the normal anatomy of the mammalian lung, with full instructions for mounting, &c.]

Sci.-Gossip, 1883, p. 66.

MAXSON, E. R.—The Microscopy of Nutrition.

[Concluding words of Address to the Syracuse Microscopical Society.]

Amer. Mon. Micr. Journ., IV. (1883) p. 38.

MAYER, S.—Beitrag zur Histologischen Technik. (Contribution to Histological Technics.) [*Post.*]

SB. K. Akad. Wiss. Wien, 3e Abtheil., LXXXV. (1882) pp. 69–82 (2 pls.).

MULLER, C. J.—On the discrimination of different species of Wood for microscopical examination.

[The tabular classification of cross-sections of wood alluded to in previous note *ante*, p. 151.]

Sci.-Gossip (1883) pp. 39–41.

NICAT, W. See Ranvier, L.

PARKER, T. J.—On the preservation of Invertebrata. *New Zeal. Journ. Sci.*, I. (1882) pp. 21–4.

PFITZER, E.—Ueber ein Härtung und Färbung vereinigendes Verfahren für die Untersuchung des plasmatischen Zellleibs. (On a hardening and staining process for the investigation of the protoplasm of the cell-body.) *Ber. Deutsch. Bot. Gesell.*, I. (1883) pp. 44–7.

POW, W. J.—Carbolic Acid in mounting. [*Supra*, p. 296.] *Amer. Mon. Micr. Journ.*, IV. (1883) pp. 8–9.

RANVIER'S (L.) Technisches Lehrbuch der Histologie. (Ranvier's Technical Compendium of Histology.) Translated by W. Nicat and H. von Wyss. 898 pp. and 324 figs. 8vo, Leipzig, 1877–82.

RETZIUS, G. See Key, A.

RICHARDSON, B. W.—Treble Staining with picrocarmine and iodine green. Exhibition of sections illustrating Triple Staining.

[Preliminary to I. (1881) p. 868.]

Ann. & Mag. Nat. Hist., XI. (1883) pp. 212–3.

SCHULZE, F. E.—Ein Schnittstrecker. (A section-stretcher.) [*Post.*] *Zool. Anzeig.*, VI. (1883) pp. 100–3 (1 fig.).

SELENKA, E.—Zur Aufstellung von Spirituspräparaten. (On putting up spirit preparations.)

[Deals principally with a guttapercha (3-7ths) and tallow (4-7ths) cement for glass vessels, and isinglass and white of egg for fixing the objects on glass plates.]

Zool. Anzeig., V. (1882) pp. 169–72.

Shepard's (C.) Preparations of Mineral Crystals.

[Cells turned from 3-8ths in. and 1-4th in. brass tubing, with upper edge rounded off—cork bottom—crystals mounted on sealing-wax—no cover—can be attached to a slide or not as desired.]

Amer. Mon. Micr. Journ., IV. (1883) p. 37.

Sigsworth, J. C.—Paper clip for mounting.

[Cf. Vol. II. (1882) p. 446. Small curved steel spring screwed upon a piece of cedar. More useful than the American clips, which have a want of parallelism.]

Journ. Quek. Micr. Club, I. (1883) p. 138.

Slack, H. J.—Pleasant Hours with the Microscope.

[Silica films—*post.*]

Knowledge, III. (1883) pp. 82–3.

" " [On making vinegar and the vinegar plant.]

Knowledge, III. (1883) pp. 114–5.

" " ["Tool and implement-making processes" in lower organisms. (Sponges and Insects).]

Knowledge, III. (1883) p. 163.

Smith, J.—A Method of Making and Mounting Transparent Rock-sections for Microscopic Slides. *Journ. Post. Micr. Soc.*, II. (1883) pp. 28–33 (2 figs.).

Tschirch, A.—Micro-chemical reaction Methods. [*Post.*]

Journ. Chem. Soc. Abstr., XLIV. (1883) pp. 376–8, from *Arch. Pharm.*, XX. (1882) pp. 801–12.

Van Brunt, C.—Removing air from Diatoms.

[The frustules are dried on the cover-glass, which is then placed on a slide, diatoms up, and plain balsam is dropped upon them. By heat the balsam is caused to flow round the diatoms. It does not replace all the air within them, but by alternately heating the balsam up to the boiling-point and then cooling it, two or three times, all the air can be expelled.]

Amer. Mon. Micr. Journ., IV. (1883) p. 39.

Vorce, C. M.—The Detection of Adulteration in Food. Illustrated.

Amer. Mon. Micr. Journ., IV. (1883) pp. 24–6.

Walmsley, W. H.—Some hints on the preparation and mounting of microscopic objects. IV.

[Fluid mountings—best method of using the fluids and rendering the mount permanent.]

The Microscope, II. (1883) pp. 179–86 (5 figs.).

Winchell, A.—The use of the Microscope in Geology.

[Suggestions to use the Microscope for the examination of fossil corals and Brachiopoda, *Eozoon*, and rock sections.]

The Microscope, II. (1883) pp. 177–9.

Wyss, H. von. See Ranvier, L.

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 14th February, 1883, at King's College, Strand, W.C., the President (Prof. P. Martin Duncan, F.R.S.), in the Chair.

The Minutes of the meeting of 10th January last were read and confirmed, and were signed by the Chairman.

The Treasurer (Dr. Beale, F.R.S.) read his Statement of the Income and Expenditure of the Society for the past year (see p. 316).

The adoption of the Treasurer's Statement was moved by Dr. Millar and seconded by Mr. Groves, and carried unanimously.

The Report of the Council was read by Mr. Crisp (see p. 315).

The adoption of the Report was moved by Mr. Curties and seconded by Mr. Beck, who said that he did so with very great pleasure as he felt that the energy which was shown in the conduct of the Society's affairs was deserving of the highest praise. Mr. Beck also made some remarks on the loan of books from the Library, to which Mr. Crisp replied.

The List of Fellows proposed as Officers and Council for the ensuing year was read as follows:—

President—Prof. P. Martin Duncan, M.B., F.R.S.

Vice-Presidents—Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *James Glaisher, Esq., F.R.S., F.R.A.S.; Robert Hudson, Esq., F.R.S., F.L.S.; *Charles Stewart, Esq., M.R.C.S., F.L.S.

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

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

Twelve other Members of Council—*John Anthony, Esq., M.D., F.R.C.P.L.; *Alfred William Bennett, Esq., M.A., B.Sc., F.L.S.; *William John Gray, Esq., M.D.; J. William Groves, Esq.; A. de Souza Guimaraens, Esq.; John E. Ingpen, Esq.; *John Matthews, Esq., M.D.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P., F.L.S.; William Thomas Suffolk, Esq.; Frederick H. Ward, Esq., M.R.C.S.

Mr. Beck and Mr. Reed having been appointed Scrutineers by the President the ballot was proceeded with, and the Scrutineers having handed in their certificate of the result of the ballot, the President declared the Fellows who had been nominated to be duly elected as Officers and Council for the ensuing year.

Mr. Glaisher said it would be noticed that in the list just read the name of Mr. Stewart no longer appeared as one of their Secretaries;

* Have not held during the preceding year the office for which they were nominated.

and he rose to ask the Meeting to give to that gentleman the very warmest possible vote of thanks for the eminently valuable services which he had rendered to the Society. They all knew his readiness to assist at their meetings, and how ably he had come forward at all times to illustrate not only his own but the communications of other Fellows, and in this and other ways had laid all the Fellows of the Society under the greatest debt of gratitude to him.

Mr. Beck seconded the motion as it had been his privilege ten years ago to propose Mr. Stewart as Secretary, and most cordially agreed with the mover of the vote of thanks as to the value of the services which had been so efficiently rendered to the Society.

The President, having put the vote to the Meeting and declared it to be carried by acclamation, said that he could only express his entire concurrence with the terms of the resolution and his personal regret that they were about to lose Mr. Stewart's companionship. He hoped, however, that it would be found that Mr. Stewart's engagements would not prevent him on some future occasion from accepting some other office in connection with the Society.

Mr. Stewart in acknowledgment said he could only thank the Fellows for the very hearty way in which they had acknowledged his efforts to serve them, having, however, a strong sense of his own shortcomings, so that he could hardly recognize the description given by the mover of the resolution as applying to himself.

The President then read his Address (see p. 172).

Mr. Michael said he felt it was hardly necessary for him to ask the Meeting to join in a cordial vote of thanks to the President for the useful address to which they had just been listening, reminding them of many points which they were apt to let slip from their memories.

Dr. Millar having seconded the motion, it was put to the Meeting and carried unanimously.

Mr. Crisp moved a vote of thanks to the Auditors and Scrutineers, which being duly seconded, was put to the Meeting and carried unanimously.

Mr. Beck, in returning thanks, said he could not sit down without alluding to the loss which had been sustained by science in the death of Professor Balfour, whom their Society was honoured by counting as one of their Vice-Presidents, and whose memory would not for a long time fade away.

Mr. Creese exhibited a new turntable, which was described by Mr. Stewart (see p. 308).

Mr. John Mayall, jun., called attention to the fact that Dr. Zeiss had adapted the correction-collar to his homogeneous-immersion objectives, the first of which class he exhibited. The correction was not, however, so much intended to correct the effect of the cover-glass

as to enable the objective to be used upon instruments having the longer tubes with which English instruments as compared with Continental ones were furnished. The tube-length allowed for was from 20 cm. to 40 cm.

Mr. Crisp made a statement in explanation of the non-publication of the paper by Prof. Abbe, which was laid before the Society in June 1880, the author not having found an opportunity to put it into shape for printing, and preferring in consequence to withdraw it from publication. Some remarks were made by Mr. Curties, Mr. Beck, and others, and a letter from Prof. Abbe on the subject read.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. W. J. Beaumont, J. W. Dunkerley, James Fleming, and J. E. Haselwood.

REPORT OF THE COUNCIL FOR 1882.

Fellows.—The number of new Ordinary Fellows elected during the year was 40, while 15 died or resigned (12 subscribers and 3 compounders), giving a net increase on the year of 25 as against 28 in 1881. One Honorary Fellow has died and two have been elected, so that the list of Fellows now stands as follows:—526 Ordinary, 50 Honorary, and 83 Ex-officio, or 659 in all.

Officers.—The assiduous attention given by the President (Prof. P. Martin Duncan, F.R.S.) to the affairs of the Society and the effective manner in which he has presided over the meetings induced the Council to recommend a suspension of the Bye-Laws to enable him to be elected for a further term. The unanimity with which the proposal was received leaves no doubt as to the approval by the Fellows of the Council's action in the matter.

The Council regret that Mr. Stewart, after having filled the office of Secretary for ten years, has found himself obliged by the pressure of his professional engagements to resign his office. On receiving his resignation the Council unanimously resolved that they "deeply regret Mr. Stewart's resignation and desire to record their sense of the very valuable services rendered by him to the Society during the term of his Secretaryship." The Annual Meeting will no doubt think it right also to warmly acknowledge Mr. Stewart's services to the Society.

Meetings.—The attendance at the meetings has been fully maintained, and the subjects on the Agenda so numerous that the time available has proved insufficient to deal with them. The Conversazioni have also been largely attended, but the Council regret that the impossibility of obtaining increased accommodation is at present an insuperable obstacle to their further extension.

THE TREASURER'S ACCOUNT FOR 1882.

Dr.

1882.	£	s.	d.
To Balance brought from 31st December, 1881	120	14	7
„ Interest on Investments	89	13	3
„ Admission Fees	67	4	0
„ Annual Subscriptions	589	8	0
„ Compositions	..	..	
„ Journals and Reprints sold by Assistant-Secretary	15	9	4
„ Screw tools sold	1	5	0
	£883	14	2

Cr.

1882.	£	s.	d.
By Rent, Gas, and Attendance	97	18	4
„ Salaries, Reporting, and Commission	141	4	6
„ Books and Binding	12	5	11
„ Expenses of Journal	300	0	0
„ Stationery and Miscellaneous Printing	33	13	9
„ Coffee at Evening Meetings	18	17	6
„ Fire Insurance	1	4	0
„ Cheque Book	0	5	0
„ Petty Cash and Postage of Journal	67	5	2
„ Subscription to Mr. Bolton's Bottles	2	2	0
„ Balance remaining 31st December, 1882	208	18	0
	£883	14	2

L. S. Beale, *Treasurer.*

Investments, 31st December, 1883.

1200*l.* Freehold Mortgages. 1057*l.* 13*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, February 14th, 1883.

J. Badcock
Thomas Curties } *Auditors.*

Library.—The Council have hitherto found it impracticable to carry out their desire to allow the books to circulate. They are, however, directing their attention to the matter, and hope to be able hereafter to announce the completion of the necessary arrangements.

Donations to the Library have been received from a few only of the Fellows. The Council will be glad of further donations of suitable books.

The Journal.—The Journal has been continued during the past year upon substantially the same plan as in the preceding.

In compliance with the desire expressed by several of the Fellows the Council sanctioned the restoration of the Bibliography, so far as it relates to either branch of Microscopy, and they understand that this arrangement has given satisfaction to the Fellows at large. Special attention has been directed to the section devoted to the preparation of objects, and it is believed that the portion of the Journal dealing with Microscopy is now as complete as it can be made having regard to the space available, and that the Fellows have before them a very comprehensive record of all that is being done in microscopy in all parts of the world.

The question of space presents a difficulty which the Council see no prospect of being able to overcome. Mr. Crisp has informed the Council that twice the present number of pages are necessary to do only bare justice to the subjects treated of, but after giving the matter full consideration it does not appear to the Council that the limit of 1000 pages which they formerly laid down can be prudently exceeded, unless the funds placed at their disposal are considerably augmented.

As notwithstanding the increase in the number printed on the commencement of the new series some of the parts are already nearly out of print the list of exchanges has been somewhat reduced, and the price of each part to non-Fellows raised to 5*s*.

MEETING OF 14TH MARCH, 1883, AT KING'S COLLEGE, STRAND, W.C., JAMES GLAISHER, ESQ., F.R.S. (VICE-PRESIDENT), IN THE CHAIR.

The Minutes of the Meeting of 14th 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
Dippel, L.—'Das Mikroskop und seine Anwendung.' 2nd ed. Part I. sec. 2. (*Ante*, p. 134)	*The Author.*
Malley, A. C.—'Micro-photography.' (*Ante*, p. 289)	*The Publisher.*
Wilder, B. G., and Gage, S. H.—'Anatomical Technology as applied to the Domestic Cat.' xxvi. and 575 pp. (130 figs.). 8vo, New York and Chicago, 1882	*Mr. Crisp.*
3 Heliotype Photomicrographs of Mosses	*Dr. F. C. Kiær.*
30 Slides of Gold, &c.	*Mr. Hanks.*
1 Slide of Diatomaceous deposit from Barbadoes	*Dr. Rae.*

Mr. G. Massee's letter was read by Mr. Bennett, descriptive of a slide of the germinating spores of *Agaricus* (*Mycena*) *epipterygius* Scop., exhibited under a Microscope in the room.

"As nothing up to the present is known respecting the germination of spores belonging to the Agaricini, I forward a slide with germinating spores of *Agaricus* (*Mycena*) *epipterygius* Scop. ; it shows no detail, and is only corroborative of the fact that the spores have been induced to germinate. The accompanying sketch shows successive stages, drawn from germinating isolated spores of same species. Germination commences after the spores have been about twelve hours in a mixture of glycerine and water. Usually only one thread is given off from the basal (apiculate) end of the spore. This continues to grow for some distance in a straight line, after which lateral branches are given off, ending in slightly swollen tips, which are filled with granular protoplasm. Rarely threads spring from both ends or from the sides of the spores. The spores of *Coprinus radiatus* Fr. germinate after a few days when placed in dilute liquid manure. The germinating tubes present much the same appearance as those described above, only the tendency to form vesicles at the tips of the secondary branches is yet more marked than in *Ag. epipterygius*."

Prof. Bell called the attention of the Meeting to nineteen slides received from the Zoological Station at Naples, the points of which he explained.

The Chairman congratulated the Meeting upon the communication made by Prof. Bell as being the first breaking of ground by their new Secretary.

Mr. H. G. Hanks' letter (State Mineralogist of San Francisco) accompanying thirty slides was read by Mr. Crisp.

Dr. James Rae's letter, accompanying a slide of diatomaceous deposit from Barbadoes, was read by Mr. Crisp.

Mr. J. Mayall, junr., exhibited a new polarizing prism, constructed after the formula devised by Prof. Silvanus P. Thompson, D.Sc., by which an angle of 18° was obtained, or nearly double that of the ordinary "Nicol" form. He believed it would be found a very practical addition to microscopical apparatus.

Dr. F. C. Kiær's letter was read by Mr. Crisp, accompanying three heliotype photomicrographs of mosses, &c.

"I send a copy of my paper, 'Genera Muscorum Macrohymenium et Phegmatodon,' &c., with three heliotype microphotographs. The objects are magnified by Nachet's objectives Nos. 1, 3, and 5, from 27 to 175 diameters. From the photographic negatives are taken positives, which are put together on the inclosed photographic plates, I. II. and III. ; from these again negatives of the same size as the

originals, and from these negatives the plates have been heliotyped. I am aware that the heliotypes have many faults, and I am only fully satisfied with the plate III. fig. 5. However, I should be pleased to have them presented to the Royal Microscopical Society if you think them of sufficient interest. My negatives have not all the same power of light, and this circumstance makes it difficult to obtain good prints of more from the same plate ; the double process of photographing the plates—which was rendered necessary because my negative glass plates had not all the same thickness—has also tended to impair the heliotypes. That will easily be seen by comparing the plate III. fig. 5 with the inclosed plate IV., which is heliotyped direct from my negative. In the future I shall only use plate-glasses of the same thickness for my sensitive plates."

Dr. Braithwaite thought the photographs were very excellent but feared that the plates were not sharp enough.

Mr. Crisp exhibited a new form of Abbe's condenser, the mounting allowing it to be used with the smaller stands, and the diaphragm consisting only of a sliding plate pierced with four apertures of different sizes.

Mr. Ingpen, in reply to a question, said there would be no difficulty in using this condenser with a proper rotary stage. He could not say that it would be in all respects as convenient as the larger form, but against this must be set the fact that there were many small instruments in use upon which the larger one could not be used at all.

Mr. Crisp read the leading points in Prof. Thoma's description of his microtome (see p. 298).

Mr. Groves exhibited and described a new form of frog-plate.

Mr. Busk's note on Paper Cells was read.

Dr. Hudson's paper on "Five New Floscules, with a Note on Prof. Leidy's Genera of *Acyclus* and *Dictyophora*" was read (see p. 161) and illustrated by drawings enlarged upon the board by Mr. Stewart.

Mr. Crisp thought it a matter for remark that at this day five new species of such a Rotifer as *Floscularia* should have been found.

Mr. Ingpen said that they had been obtained from quite new ground near Dundee.

Prof. Bell remarked that one of the five had since been found by Mr. Bolton near Manchester.

Mr. Badcock thought it ought to encourage collectors to search much more carefully in their old localities, though these, unfortunately, were becoming more and more reduced in consequence of encroachments.

Mr. Waddington read his paper on "The Action of Tannin on the Cilia of Infusoria" (see p. 185).

Mr. Crisp thought that those Fellows who saw the slide of *Paramœcium* exhibited by Mr. Waddington would be struck by the very extraordinary appearance it presented.

Mr. Ingpen inquired if Mr. Waddington had been able to mount the Infusoria, and what medium would be likely to prove the best chemically for the purpose.

Mr. Waddington thought he should prefer dense gelatine, but no doubt a great deal of washing would be required previously in order to get rid of the tannin.

Mr. Badcock asked if Mr. Waddington could account for any difference between the action of the acid on the cilia of the *Paramœcium* and the setæ of other Infusoria.

Mr. Waddington said he could not explain the difference, except that possibly the setæ being thicker might require a longer exposure to the action of the tannin.

Mr. Stewart thought the explanation would probably be found in the difference of development of the cuticular layer which in some species was much thicker than in others; the more exposed bodies of the *Paramœcia* would cause them to succumb almost at once to the action of the acid.

Mr. Webb's paper "On Diamond and other Jewel Lenses for the Microscope" was taken as read.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—19 slides from the Naples Zoological Station.

Mr. T. Christy:—Seed of *Protea cynaroides*.

Mr. Crisp:—(1) Abbe's Condenser for small stands. (2) Gundlach's Substage Refractor. (3) Gundlach's Symmetrical Illuminator. (4) Chevalier's Camera Lucida for vertical Microscopes.

Mr. Groves:—New Frog-plate.

Messrs. How & Co.:—Pocket Lamp.

Mr. G. Massee:—Germinating Spores of *Agaricus* (*Mycena*) *epipterygius*.

Mr. J. Mayall, jun.:—Dr. S. P. Thompson's Polarizing Prism.

Mr. T. Powell:—1-12th in. Oil-immersion Objective 1·47 N.A., the front being set in the usual way, without a thin plate of glass.

Dr. J. Rae:—Slide of Diatomaceous deposit from Barbadoes.

Mr. Waddington:—Infusoria treated with Tannin.

New Fellows:—The following were elected *Ordinary Fellows*:—Messrs. George W. Carter, M.A., George F. Chantrell, William Saunders, and William Stanley. And as *ex-officio Fellow* the President for the time being of the Carlisle Microscopical Society.

WALTER W. REEVES,
Assist.-Secretary.

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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WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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

FELLOWS OF THE SOCIETY.

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

The Journal comprises:

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

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

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

It consists of Ordinary, Honorary, and Ex-officio Fellows.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 10*s.* Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

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

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

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

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

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I. Numerical Aperture Table.

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

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

Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power (¼ in.) from 0·50 to 1·52 N. A.	Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture (= 2 u). *Dry* Objectives. ($n = 1$.)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)	Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. (A=0·5269 μ =line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
1·52	1·52	..	..	180° 0′	2·310	146,528	·658
	1·50	..	..	161° 23′	2·250	144,600	·667
	1·48	..	..	153° 39′	2·190	142,672	·676
	1·46	..	..	147° 42′	2·132	140,744	·685
	1·44	..	..	142° 40′	2·074	138,816	·694
	1·42	..	..	138° 12′	2·016	136,888	·704
	1·40	..	..	134° 10′	1·960	134,960	·714
	1·38	..	..	130° 26′	1·904	133,032	·725
	1·36	..	..	126° 57′	1·850	131,104	·735
	1·34	..	..	123° 40′	1·796	129,176	·746
1·33	1·33	..	180° 0′	122° 6′	1·770	128,212	·752
	1·32	..	165° 56′	120° 33	1·742	127,248	·758
	1·30	..	155° 38′	117° 34′	1·690	125,320	·769
	1·28	..	148° 28′	114° 44′	1·638	123,392	·781
	1·26	..	142° 39′	111° 59′	1·588	121,464	·794
	1·24	..	137° 36′	109° 20′	1·538	119,536	·806
	1·22	..	133° 4′	106° 45′	1·488	117,608	·820
	1·20	..	128° 55′	104° 15′	1·440	115,680	·833
1·16	1·18	..	125° 3′	101° 50′	1·392	113,752	·847
	1·16	..	121° 26′	99° 29′	1·346	111,824	·862
	1·14	..	118° 00′	97° 11′	1·300	109,896	·877
	1·12	..	114° 44′	94° 56′	1·254	107,968	·893
	1·10	..	111° 36′	92° 43′	1·210	106,040	·909
	1·08	..	108° 36′	90° 33′	1·166	104,112	·926
	1·06	..	105° 42′	88° 26′	1·124	102,184	·943
1·0	1·04	..	102° 53′	86° 21′	1·082	100,256	·962
	1·02	..	100° 10′	84° 18′	1·040	98,328	·980
	1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
	0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
	0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
	0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
·90	0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
	0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
	0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
	0·86	118° 38′	80° 34′	68° 51′	·740	82,904	1·163
	0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
·80	0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
	0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1·250
	0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
	0·76	98° 55′	69° 42′	60° 0′	·578	73,264	1·316
	0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
·70	0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
	0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
	0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
	0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
	0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
·60	0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
	0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
	0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
	0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
	0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
·50	0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
	0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

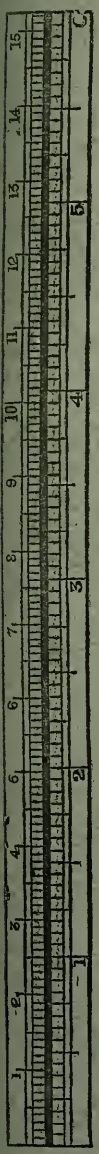
EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

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

mm. and cm. ins.



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

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

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

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

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

ins.	μ
1/25000	1·015991
1/20000	1·269989
1/15000	1·693318
1/10000	2·539977
1/9000	2·822197
1/8000	3·174972
1/7000	3·628539
1/6000	4·233295
1/5000	5·079954
1/4000	6·349943
1/3000	8·466591
1/2000	12·699886
1/1000	25·399772
	mm.
1/900	·028222
1/800	·031750
1/700	·036285
1/600	·042333
1/500	·050800
1/450	·056444
1/400	·063499
1/350	·072571
1/300	·084666
1/250	·101599
1/200	·126999
1/150	·169332
1/100	·253998
1/50	·507995
1/25	1·015991
1/20	1·269989
1/16	1·587486
1/15	1·693318
1/12	2·116648
1/10	2·539977
1/8	3·174972
1/6	4·233295
3/16	4·762457
1/5	5·079954
1/4	6·349943
5/16	7·937429
3/8	9·524915
	cm.
7/16	1.111240
1/2	1·269989
9/16	1·428737
5/8	1·587486
11/16	1·746234
3/4	1·904983
13/16	2·063732
7/8	2·222480
15/16	2·381229
1	2·539977
2	5·079954
3	7·619932
	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973
	metres.
1 yd.=	·914392

Conversion of British and Metric Measures—*continued.*

(2.) Capacity.

Millilitres, &c., into Cubic Inches, &c.

millilitres.		cub. ins.
1		·061025
2		·122051
3		·183076
4		·244102
5		·305127
6		·366152
7		·427178
8		·488203
9		·549228
10	(1 centil.)	·610254
20		1·220508
30		1·830762
40		2·441015
50		3·051269
60		3·661523
70		4.271777
80		4·882031
90		5·492285
100	(1 decil.)	6·102539
200		12·205077
300		18·307616
400		24·410155
500		30·512693
600		36·615232
700		42·717771
800		48·820309
900		54·922848
1000	(1 litre)	61·025387

= ·035315 cub. ft.

= 1·760724 pints.

= ·220091 galls.

Cubic Inches, &c., into Millilitres, &c.

cub. ins.	millilitres.
·1	1·638662
·2	3·277325
·3	4·915987
·4	6·554649
·5	8·193311
·6	9·831974
	centilitres.
·7	1·147064
·8	1·310930
·9	1·474796
1	1·638662
2	3·277325
3	4·915987
4	6·554649
5	8·193311
6	9·831974
	decilitres.
7	1·147064
8	1·310930
9	1·474796
10	1·638662
20	3·277325
30	4·915987
40	6·554649
50	8·193311
60	9·831974
	litres.
70	1·147064
80	1·310930
90	1·474796
100	1·638662

277·274 (1 gall.) = 4·543584 litres.

(3.) Weight.

Milligrammes, &c., into Grains, &c.

milligrammes.		grains.
1		·015432
2		·030865
3		·046297
4		·061729
5		·077162
6		·092594
7		·108026
8		·123459
9		·138891
10	(1 centigr.)	·154323
20		·308647
30		·462970
40		·617294
50		·771617
60		·925941
70		1·080264
80		1·234588
90		1·388911
100	(1 decigr.)	
decigrammes.		
1		1·543235
2		3·086470
3		4·629705
4		6·172939
5		7·716174
6		9·259409
7		10·802644
8		12·345879
9		13·889114
10	(1 gr.)	15·432349
		oz. avoir.
100	(1 decagr.)	·352739
1000	(1 hectogr.)	3·527394
		lbs. avoir.
10000	(1 kilogr.)	2·204620

Grains, &c., into Milligrammes, &c.

grains.		milligrammes.
·01		·647989
·02		1·295979
·03		1·943969
·04		2·591958
·05		3·239948
·06		3·887937
·07		4·535927
·08		5·183916
·09		5·831906
·1		6·479895
		centigrammes.
·2		1·295979
·3		1·943969
·4		2·391958
·5		3·239948
·6		3·887937
·7		4·535927
·8		5·183916
·9		5·831906
1		6·479895
		decigrammes.
2		1·295979
3		1·943969
4		2·591958
5		3·239948
6		3·887937
7		4·535927
8		5·183916
9		5·831906
10		6·479895
		grammes.
100		6·479895
	avoir.	decagrammes.
437·5	(1 oz.)	2·834954
		hectogrammes.
7000	(1 lb.)	4·535927
		= ·453593 kilogrammes.

III. Corresponding Degrees in the Fahrenheit and Centigrade Scales.

Fahr.	Cent.	Cent.	Fahr.
500	260·0	100	212·0
450	232·22	98	208·4
400	204·44	96	204·8
350	176·67	94	201·2
300	148·89	92	197·6
250	121·11	90	194·0
212	100·0	88	190·4
210	98·89	86	186·8
205	96·11	84	183·2
200	93·33	82	179·6
195	90·56	80	176·0
190	87·78	78	172·4
185	85·0	76	168·8
180	82·22	74	165·2
175	79·44	72	161·6
170	76·67	70	158·0
165	73·89	68	154·4
160	71·11	66	150·8
155	68·33	64	147·2
150	65·56	62	143·6
145	62·78	60	140·0
140	60·0	58	136·4
135	57·22	56	132·8
130	54·44	54	129·2
125	51·67	52	125·6
120	48·89	50	122·0
115	46·11	48	118·4
110	43·33	46	114·8
105	40·56	44	111·2
100	37·78	42	107·6
95	35·0	40	104·0
90	32·22	38	100·4
85	29·44	36	96·8
80	26·67	34	93·2
75	23·89	32	89·6
70	21·11	30	86·0
65	18·33	28	82·4
60	15·56	26	78·8
55	12·78	24	75·2
50	10·0	22	71·6
45	7·22	20	68·0
40	4·44	18	64·4
35	1·67	16	60·8
32	0·0	14	57·2
30	− 1·11	12	53·6
25	− 3·89	10	50·0
20	− 6·67	8	46·4
15	− 9·44	6	42·8
10	− 12·22	4	39·2
5	− 15·0	2	35·6
0	− 17·78	0	32·0
− 5	− 20·56	− 2	28·4
− 10	− 23·33	− 4	24·8
− 15	− 26·11	− 6	21·2
− 20	− 28·89	− 8	17·6
− 25	− 31·67	− 10	14·0
− 30	− 34·44	− 12	10·4
− 35	− 37·22	− 14	6·8
− 40	− 40·0	− 16	3·2
− 45	− 42·78	− 18	− 0·4
− 50	− 45·56	− 20	− 4·0

IV. Refractive Indices, Dispersive Powers, and Polarizing Angles.

(1.) Refractive Indices.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air (at 0° C. 760 *mm.*)

(2.) Dispersive Powers.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp. gr. ·932)
Oil of turpentine (sp. gr. ·885)
Alcohol
Sea water
Pure water
Air

(3.) Polarizing Angles.

Diamond
Phosphorus
Bisulphide of carbon
Flint glass
Crown glass
Rock salt
Canada balsam
Linseed oil (sp .gr. ·932)
Oil of turpentine (sp. gr. ·886)
Alcohol
Sea water
Pure water
Air

[Exact data for these tables are at present wanting.]

V. Table of Magnifying Powers.

OBJECTIVES.		EYE-PIECES.								
Focal Length.	Magnifying Power.	Beck's 1, Powell's 1, Ross's A.	Beck's 2, Powell's 2, and Ross's B, nearly.*	Powell's 3.	Ross's C.	Beck's 3.	Beck's 4, Powell's 4, Ross's D.	Beck's 5, Ross's E.	Powell's 5.	Ross's F.
		Focal Length.								
		2 in.	$1\frac{1}{3}$ in.	1 in.	$\frac{4}{5}$ in.	$\frac{2}{3}$ in.	$\frac{1}{2}$ in.	$\frac{4}{10}$ in.	$\frac{1}{3}$ in.	$\frac{1}{4}$ in.
		Magnifying Power.								
		5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	20	25	30	40
		Amplification of Objectives and Eye-pieces combined.								
ins. 5	2	10	15	20	25	30	40	50	60	80
4	$2\frac{1}{2}$	$12\frac{1}{2}$	$18\frac{3}{4}$	25	$31\frac{1}{4}$	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100
3	$3\frac{1}{3}$	$16\frac{2}{3}$	25	$33\frac{1}{3}$	$41\frac{2}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$
2	5	25	$37\frac{1}{2}$	50	$62\frac{1}{2}$	75	100	125	150	200
$1\frac{1}{2}$	$6\frac{2}{3}$	$33\frac{1}{3}$	50	$66\frac{2}{3}$	$83\frac{1}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$
1	10	50	75	100	125	150	200	250	300	400
$\frac{8}{10}$	$12\frac{1}{2}$	$62\frac{1}{2}$	$93\frac{3}{4}$	125	$156\frac{1}{4}$	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500
$\frac{2}{3}$	$13\frac{1}{3}$	$66\frac{2}{3}$	100	$133\frac{1}{3}$	$166\frac{2}{3}$	200	$266\frac{2}{3}$	$333\frac{1}{3}$	400	$533\frac{1}{3}$
$\frac{2}{4}$	15	75	$112\frac{1}{2}$	150	$187\frac{1}{2}$	225	300	375	450	600
$\frac{1}{2}$	20	100	150	200	250	300	400	500	600	800
$\frac{4}{10}$	25	125	$187\frac{1}{2}$	250	$312\frac{1}{2}$	375	500	625	750	1000
$\frac{1}{3}$	30	150	225	300	375	450	600	750	900	1200
$\frac{3}{10}$	$33\frac{1}{3}$	$166\frac{2}{3}$	250	$333\frac{1}{3}$	$416\frac{2}{3}$	500	$666\frac{2}{3}$	$833\frac{1}{3}$	1000	$1333\frac{1}{3}$
$\frac{1}{4}$	40	200	300	400	500	600	800	1000	1200	1600
$\frac{1}{5}$	50	250	375	500	625	750	1000	1250	1500	2000
$\frac{1}{6}$	60	300	450	600	750	900	1200	1500	1800	2400
$\frac{1}{7}$	70	350	525	700	875	1050	1400	1750	2100	2800
$\frac{1}{8}$	80	400	600	800	1000	1200	1600	2000	2400	3200
$\frac{1}{9}$	90	450	675	900	1125	1350	1800	2250	2700	3600
$\frac{1}{10}$	100	500	750	1000	1250	1500	2000	2500	3000	4000
$\frac{1}{11}$	110	550	825	1100	1375	1650	2200	2750	3300	4400
$\frac{1}{12}$	120	600	900	1200	1500	1800	2400	3000	3600	4800
$\frac{1}{13}$	130	650	975	1300	1625	1950	2600	3250	3900	5200
$\frac{1}{14}$	140	700	1050	1400	1750	2100	2800	3500	4200	5600
$\frac{1}{15}$	150	750	1125	1500	1875	2250	3000	3750	4500	6000
$\frac{1}{16}$	160	800	1200	1600	2000	2400	3200	4000	4800	6400
$\frac{1}{17}$	170	850	1275	1700	2125	2550	3400	4250	5100	6800
$\frac{1}{18}$	180	900	1350	1800	2250	2700	3600	4500	5400	7200
$\frac{1}{19}$	190	950	1425	1900	2375	2850	3800	4750	5700	7600
$\frac{1}{20}$	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
$\frac{1}{25}$	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
$\frac{1}{30}$	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
$\frac{1}{40}$	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
$\frac{1}{50}$	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
$\frac{1}{60}$	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
$\frac{1}{80}$	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power, or respectively $\frac{1}{7}$ less and $\frac{1}{15}$ more than the figures given in this column.

Royal Microscopical Society.

MEETINGS FOR 1883,

AT 8 P.M.

1883.	Wednesday,	JANUARY	10
	„	FEBRUARY	14
		(Annual Meeting for Election of Officers and Council.)	
	„	MARCH	14
	„	APRIL	11
	„	MAY	9
	„	JUNE	13
	„	OCTOBER	10
	„	NOVEMBER	14
	„	DECEMBER	12

THE "SOCIETY" STANDARD SCREW.

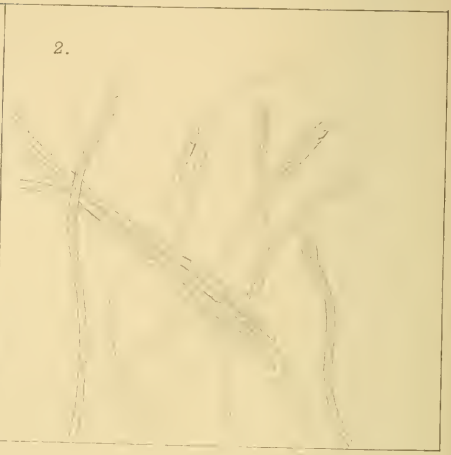
The Council have made arrangements for a further supply of Gauges and Screw-tools for the "SOCIETY" STANDARD SCREW for OBJECTIVES.

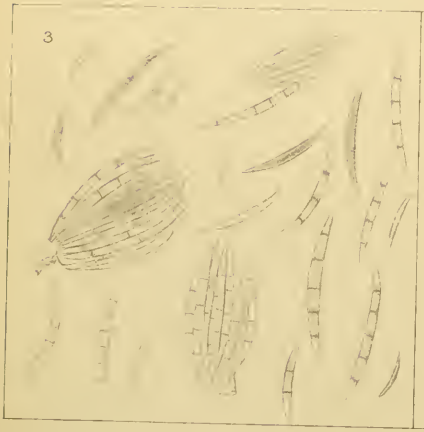
The price of the set (consisting of Gauge and pair of Screw-tools) is 12*s.* 6*d.* (post free 12*s.* 10*d.*). Applications for sets should be made to the Assistant-Secretary.

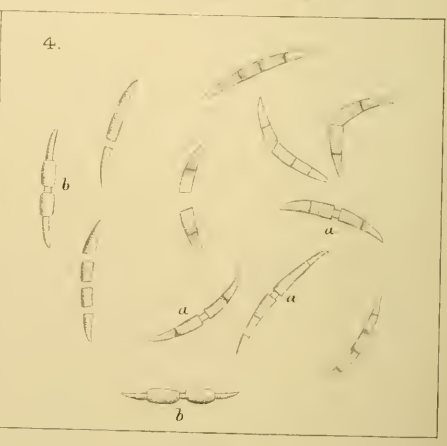
For an explanation of the intended use of the gauge, see Journal of the Society, I. (1881) pp. 548–9.

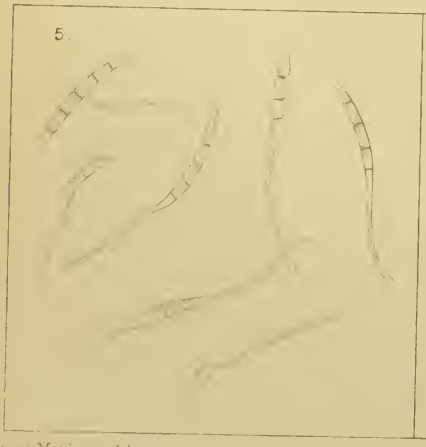
ADVERTISEMENTS FOR THE JOURNAL.

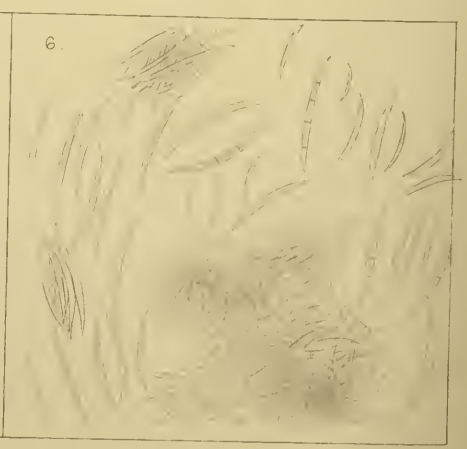
Mr. CHARLES BLENCOWE, of 75, Chancery Lane, W.C., is the authorized Agent and Collector for Advertising Accounts on behalf of the Society.







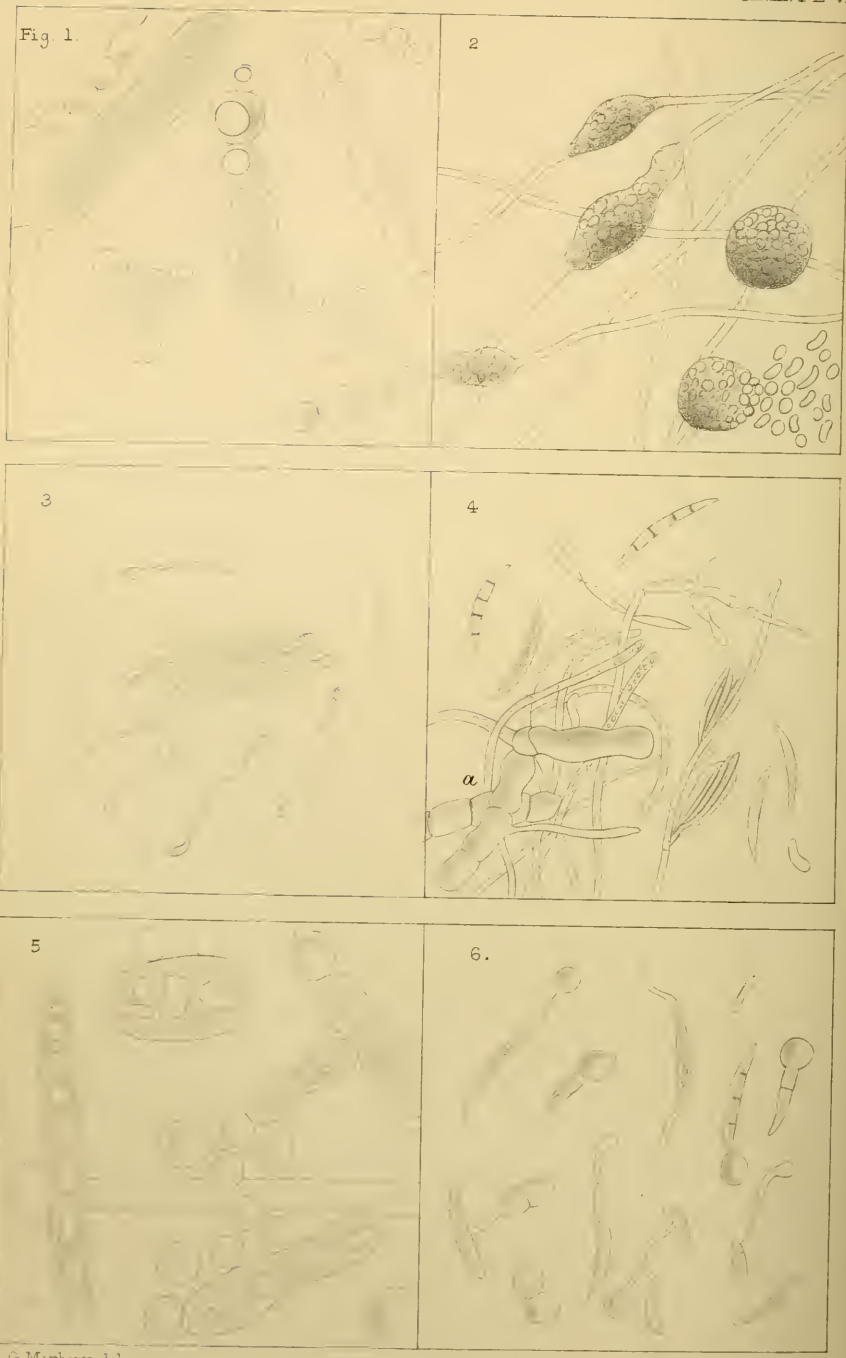




Matthews del.

West Newman & C° sc

Red Mould of Barley.



C. G. Matthews del.

West Newman & C° sc

Red Mould of Barley

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE 1883.

TRANSACTIONS OF THE SOCIETY.

VII.—*On the Red Mould of Barley.*

By Charles George Matthews, F.C.S., F.I.C.

(*Read* 11*th April*, 1883.)

Plates V. and VI.

During the malting season of 1879-80, when the quality of the majority of samples of English-grown barleys was decidedly inferior, my attention was directed to the frequent occurrence of so-called "red corns" amongst the couches at a small malt-house where various samples of English barley were being worked up. Since it was evident, on a very cursory inspection, that the red corns owed their peculiar appearance to a definite mould-growth, I made search in such treatises on the moulds as were at my command, for information bearing on this mould in particular; but was unable to find any reference to it. It then occurred to me to communicate

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EXPLANATION OF PLATES V. AND VI.

Plate V.

Fig. 1.—Barley corns with and without red mould.
„ 2.—Pseudo-sporulation of red mould.
„ 3.—Crescent spores of red mould.
„ 4.—Spores dividing at septa; *a*, *b*, peculiar forms.
„ 5.—Germinating crescent spores of red mould.
„ 6.—Red mould as detached from the corn.

Plate VI.

Fig. 1.—Red mould growing as a ferment.
„ 2.—Third sporulation of red mould.
„ 3.—Germinating spores of red mould.
„ 4.—Melon mould; *a*, submerged portion.
„ 5.— „ growing as a ferment.
„ 6.— „ spores sprouting.

with Dr. Chr. Hansen, of the Carlsberg Laboratory, Copenhagen, who has given much time and attention to the microscopic fungi. Dr. Hansen kindly informed me that the mould I had described to him was either *Fusarium graminearum* or some closely allied species; and that its life-history had not been traced. Seeing that this was the case, and feeling an interest in the matter, I endeavoured to obtain a closer knowledge of the mould by cultivation on natural and artificial nutrient substances, and frequent examination under the Microscope at different stages of its growth. Where a low magnifying power was required, a combination of a Ross's B eye-piece, and 1-in. objective was used; for a more minute examination the same eye-piece and 1-5th in. objective (Ross) were employed.

To the maltster the appearance of these red corns is probably not unfamiliar, though they are only seen in any quantity during the malting of inferior barleys. The mould is chiefly at the germinal end of the corn, and exhibits a conspicuous crimson colour. I will reserve further remarks on the character of the affected corns till a later part of these notes.

To proceed now to the examination of the crimson-coloured matter on the exterior of the corns affected with the mould. A small quantity was detached and gently stirred into a drop of water on a glass slide, a cover-glass being then pressed on to it. On applying a high magnifying power large numbers of crescent- or spindle-shaped bodies were perceived, together with filamentary fragments, starch-granules, and amorphous matter tinted with the red colouring (see plate V. fig. 6). The question naturally arises as to the origin of this and commoner forms of mould, to which barley and other cereals, under certain conditions, fall a prey. It is well known that the air of populous districts contains various and multitudinous particles in suspension, which are being constantly deposited on resting surfaces as dust, and it has been shown by eminent scientists, that the dust (which consists for the most part of microscopic particles) includes various organisms such as bacteria, infusoria, ferment-cells, and spores of the commoner moulds, generally in a state of desiccation. An experiment was made to determine the constituents of the dust adherent to barley. A quantity of barley (about 50 gms.) was steeped in a suitable volume of water for about 12 hours, the containing vessel being occasionally well shaken; at the end of the time and after shaking once more, the water was poured off, a little fresh water being then added, which after shaking up and separating from the barley (which was neglected), was added to the first portion and the whole put into a glass cylinder, the suspended matter being allowed to settle. After a minute or two had elapsed the liquid was poured off from the coarse particles and put into a second cylinder, where it was allowed

to remain for a few hours, when a deposition of the finer particles in suspension took place.

The deposit in each case was examined under the Microscope; that from cylinder No. 1 showed only earthy particles, humus, and sand, and was neglected. The deposit from No. 2 cylinder yielded several objects of interest, such as bacteria, infusoria, and mould spores. Among the latter were crescent spores of the red mould now under consideration.

Various kinds of barley, including Saale, French, Chilian, and Californian samples, were treated as above, and yielded similar bodies, though in varying quantities. An examination of the accumulated dust under barley-heaps was also made: the greater portion consisted of earthy matter, but in addition, mould spores, infusoria, and bacteria were found similar to those obtained from barley. The washings of oats, horse-beans, and the ripe ear of wheat also yielded some or other of the organisms described.

There can be little doubt, then, that in the first stage of the malting process the spores of various moulds are present in quantity in the "steep," being introduced into the cistern with the barley, and although the greater portion may be removed on withdrawal of the steep-water, yet even if the air did not furnish fresh spores, there would be left, in all probability, sufficient to cause a mould-growth on injured or weakly corns whilst on the malting floor, other conditions being favourable thereto.

In order that a thorough examination of the growing red mould might be made, it was necessary to find convenient methods of cultivation, and to this end various experiments were undertaken. The first thing tried was the crushing and moistening of the affected corns, the mass thus formed being allowed to develope the mould under a glass shade. In this way small tufts of the mould were obtained, but it appeared desirable to grow it on a larger scale, and to do this, germinating barley from the fifth day and upward out of steep was worked into a stiff paste by pestle and mortar, a little water being added to assist the operation. This paste was then put into small dishes, and a few red corns were partially imbedded in each quantity, the dishes being placed in a wire frame, resting on an ordinary china plate containing a little water, the arrangement being completed by covering with a bell-glass.

Very fine silky tufts of the red mould were thus obtained from 1-2 to 3-4ths in. in height and nearly 2 inches in diameter, spread over the nourishing surface, and with no tendency, during the winter months, to invasion by the commonly occurring moulds. In each cultivation there was a considerable production of the crimson colouring matter which was diffused amongst the plasma, and the hyphæ were tinged with it where they sprang from the

nutrient surface, though their extremities were colourless. These growths constituted very interesting objects.

Various plasmas were impregnated with the mould, the results obtained being detailed below.

Crushed malt worked with water into a stiff paste	Very indifferent growth.
Slices of cooked turnip and potato ..	Fairly well; invasion of other moulds.
„ raw turnip and potato ..	Hardly any growth.
„ melon	Very indifferently.
Cooked meat	„
Raw meat	Hardly any growth.

For the following microscopical observations the mould under consideration was cultivated on crushed germinating barley, the best growths being obtained with this form of nourishment. The tufts of mould, which formed in about ten days from the time of sowing, consisted of a mass of hyphæ, indistinguishable as such from those of many other moulds. These hyphæ gradually become interlaced, and in two or three weeks' time, owing to their increasing weight, begin to droop and the tuft flattens down; just at this time a kind of sporulation was observed (fig. 2).

I would here make a few remarks as to the method employed for the collection and treatment of small portions of the mould-growths for microscopical observation, as some difficulty was at first experienced in removing portions from the growing mass, owing to the tendency the hyphæ have to adhere persistently to each other when disturbed. After examining the growth with a low power (55 diameters), small glass hairs rounded at the ends in a Bunsen flame were used to detach portions for examination under the higher power (300 diameters). A drop of dilute alcohol was allowed to fall upon them from a small pipette, a cover-glass being gently pressed on. Dilute alcohol is preferable to water for general use, for the portion of mould under treatment has less tendency to alter its existing contour on immersion in the former than in the latter.

To revert again to the sporulation shown in fig. 2, I spoke of this purposely as a kind of sporulation, for as two more methods of sporulation were observed of a true character, and seeing that in no case was the regeneration of the mould perceived from the bodies depicted as escaping from the hyphæ, I have been led to regard this as an abortive sporulation, and the minute bodies as pseudo-spores.

Up to this point no crescent-shaped bodies were noticed in any of the cultures, despite the extensive production of colouring matter similar to that on the red corns.

Shortly after the flattening down of the tuft of mould a pink dust was perceived in minute patches on the whitish surface. On examination this was found to consist of clusters of crescent-shaped spores (fig. 3), attached by their pointed ends so as to form fasces, these again being attached to the plasma by short irregular hyphæ. On touching or wetting, the arrangement is at once disturbed, and the crescents falling loose, are then seen to be of varying size.

The crescents are doubtless developed by sprouting at the extremities of short hyphæ, developed on the flattened surface of the mould-growth, and not from spores discharged from an ascus (for as yet no kind of ascus had been seen), though observations made at a further stage in the development of the mould indicated that this in a limited way was quite possible.

Sometimes the pink patches spoken of became moistened by the condensation of minute drops of water on the surface of the mould, causing a reddish-orange coloured spot to be formed consisting of a mass of the crescent bodies in a resting state. From these spores, fresh growths of the mould could be obtained by sowing on a suitable nutrient surface. The colouring matter was found to be in the material surrounding the crescent spores, which are in most cases colourless, though sometimes they are faintly tinged with colour. The formation of these crescent- or spindle-shaped bodies thus constitutes a second kind of sporulation, and we may now consider the way in which they reproduce the original mould, for this they are capable of doing, thus differing from the bodies produced in the first or pseudo-sporulation.

Some of the pink-dust patches or reddish-orange spots were removed and placed in a small quantity of water; the crescent spores sink slowly to the bottom of the containing vessel, and by careful decantation can be separated from adherent matters, the water being renewed once or twice, the spores being finally left in contact with pure distilled water in a covered vessel and examined daily. Interesting changes occurred, for in the absence of nutriment, some of the spores divided at the septa (fig. 4), in some cases a short length of tube, or an abortive hypha was formed between two segments (*a*, *a*, *a*) or a swelling of some of the segments took place (*b*, *b*) distorting the crescent. In the meantime other of the crescent spores began to throw out hyphæ; some of the segments even doing the same (fig. 5). Shortly after these observations the water was poured off and the germinating spores were put on fresh plasma, when an active reproduction of the red mould shortly took place.

Several growths of the mould were allowed to go on for some few weeks, and were subjected to frequent examination, remaining at the same time free from the invasion of other moulds; for on a

suitable plasma the red mould is capable of holding its own for a considerable time against common species like *Penicillium* and *Mucor*, excepting in the summer months, when the plasma being quickly attacked by *Mycoderma vini*, *Mucor*, or bacteria, rendered a pure cultivation of the red mould a matter of some difficulty. After a time it became evident that asci or sporangia were being formed, and these eventually attained a fair size (see plate VI. fig. 2).

On moistening a single ascus with water, its contents were discharged and the spores exhibited considerable variety in shape, though they were for the most part spherical; some had a tendency to an elliptic form, and a few showed an incipient crescent shape. The elongated and irregular appearance of some of the spore-clusters (fig. 2) was caused by the rupture of the ascus, consequent on its coming into contact with the moisture which occasionally formed as a dew on the tufts.

The spores were successfully sown on fresh plasma and gave rise to an undoubted growth of the red mould. Fig. 3 shows the germination of the spores.

By a chance coincidence I was led to examine a mould-growth on a bruised portion of a Spanish melon, and was surprised to find that in several respects it resembled the red mould of barley. The first portion of the mould removed from the melon showed a quantity of crescent spores distributed amongst hyphæ (aerial and submerged), some of them identical in form with those of the red mould, others showing a variation (fig. 4). Parings of the rind of a perfectly sound melon were washed with water, at the same time going gently over them with a camel's hair brush to detach any adhering substances; the washings were examined, and showed a quantity of crescent bodies (fig. 5), which unquestionably were capable of giving rise to a mould-growth similar to that observed on the bruised melon. This melon mould also produces the crimson colouring matter; on referring again to fig. 4, a portion of the growth (*a*) will be seen which I have no doubt was caused by the submerging of some of the hyphæ in the juicy portion of the fruit.

On exhausting the spores with pure water, as in the case of those of the red mould, their behaviour was dissimilar, for no separation into segments took place, and the sprouting was of a very limited character, the hypha terminating in a spherical or rounded cell, which in some cases sent out a bud, thus forming a pair of cells which sometimes became detached from the crescent spore (fig. 6). Distortion of the crescents occasionally ensued. The mould was regenerated from the crescent spores, and allowed to grow freely for some weeks, during which time crescent spores were formed in bundles attached to the hyphæ (fig. 4), no ascus

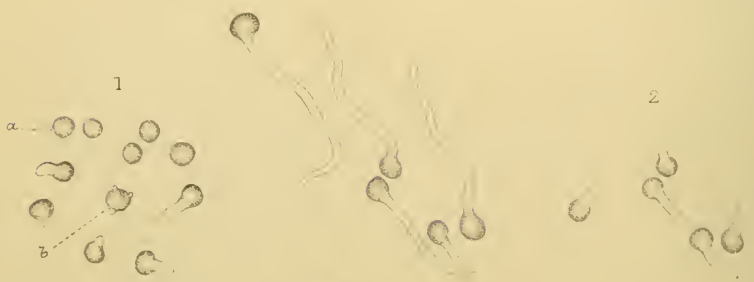
being formed. Colouring matter was produced as before. The melon mould had little or no tendency to grow on the crushed germinating barley food, whilst the barley mould in the same way declined to flourish on pieces of melon. The close likeness existing between the crescent spores of each mould is the chief point of interest—indeed, spores of each may be selected that are indistinguishable. In many other respects the moulds are dissimilar.

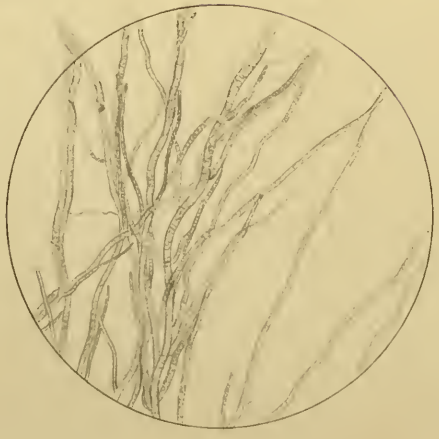
Each of the two moulds described was introduced into sterilized beer-wort of specific gravity 1·057 in separate flasks, and gave rise to characteristic ferments, closely resembling each other, and remarkable for the extraordinary size of the cells. These ferments produce alcohol and carbonic acid gas, but act in a very sluggish manner, being far less active than the ferment *Mucor*. The resulting beer has a mawkish flavour resembling that produced by the ferment just mentioned. To refer again to the sprouting of the crescent spores from the melon given in fig. 6, it would appear that the spherical bodies produced are ferment-cells, and on these becoming detached and finding themselves in a suitable fluid, reproduction by budding takes place. The ferment in each case collects into leathery flocculent masses consisting of interlaced tubes similar to *Mucor*, and inclosing in their meshes quantities of detached cells, such as in figs. 1 and 5.

To conclude with a few general remarks on the behaviour of the red mould in the "Maltings."

The growth of the mould commences at the germinal end of the corn, and spreads towards the opposite end, the rate of growth being determined by the supply of nourishment from the interior of the corn, and this again is determined by the extent of the injury the corn has received by crushing, &c. On some corns a very slight coloration is apparent, whilst others are almost covered by a crimson paste, from which hyphæ are sometimes seen springing. The corns which are subsequently the worst affected are just distinguishable amongst the dry stored barley, but many others that look like "idlers" develope the mould when on the "floors"; but it is not until they have been four or five days out of steep that their presence is observed; from this period till the time of loading the kiln the mould grows with some rapidity. The affected corns are always such as are from various causes incapable of proper germination, having perhaps been injured by heating in the stack and sprouting, or by being split or crushed during the threshing, and are generally discoloured, misshapen, and indicate by their appearance that little is to be expected of them. Occasionally in such corns an abortive growth takes place, one or more sickly brownish-looking rootlets may appear whilst the acrospire remains inactive; in others the reverse occurs, the acrospire growing to some length, the rootlets not appearing, having been shrivelled

up during a premature sprouting. Such are the corns which are found with this particular mould developed upon them. The mould is never seen on a healthy, germinating, perfect corn, and this is no doubt equally the case where the commoner moulds, e. g. *Penicillium* and *Mucor* are concerned, for although these, especially the former, spread at times with some rapidity amongst the couches, it is only when the corns are exposed to abnormal conditions of temperature causing a reduction in their vitality. It will be understood from the foregoing remarks that the red mould does not spread from corn to corn excepting where injured corns lie for some time in contact; this is probably owing to the fact that the spores are not disseminated like those of the common moulds, owing to their greater weight and their tendency to remain adherent to the original mould-growth. Corns seriously affected with the mould may be distinguished among finished malt, being rendered conspicuous by the colouring matter still adherent to them. Mould-spores can have little or no influence of themselves in the mashing process, and are undoubtedly destroyed during the boiling in the wort-copper. Nevertheless, malt exhibiting red corns must be of an inferior quality, having been prepared from an indifferent sample of barley, besides which the mould-growth will have acted in a prejudicial manner on the constituents of the corn, using up extractible matters and imparting peculiarity of flavour. I have left the consideration of the colouring matter produced by this and other moulds to the light of future experiment.





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Ringworm Fungus (Trichophyton tonsurans.)

VIII.—*The Cultivation and Life-History of the Ringworm Fungus (Trichophyton tonsurans).*

By Malcolm Morris, F.R.C.S. Ed., and G. C. Henderson, M.D., M.R.C.P.

(*Read 11th April*, 1883.)

Plate VII.

The life-history of the ringworm fungus, first discovered by Malmsten and Gruby in 1844, and its exact botanical position, still remain a matter of uncertainty. Some observers hold strongly to the belief that this fungus is a distinct species, whilst others consider it merely a variety of one of the commoner Hyphomycetes; and these again hold different opinions, ascribing it variously to *Penicillium*, *Aspergillus*, *Oidium*, and *Mucor*.

We commenced the present investigation without any bias for or against any of these views, and have been led to our conclusions by the results of our experiments alone.

Experiment 1. *Cell cultivation with aqueous humour.*—The aqueous humour was placed on the under surface of the cover-glass, which formed the top of a putty cell. In some cells an air-passage was left, while others were closed. A small quantity of distilled water was placed at the bottom of each cell to maintain the moisture of the chamber.

Hairs were removed from typical patches of untreated ringworm and were inclosed in a glass tube.

One hair was floated on a drop of aqueous humour in each cell. Spores adhering to the hair and root sheath were seen under the Microscope to be those of typical ringworm. Placed in the incubator at a temperature of 23° C., in 24 hours the two preparations with air-passages were completely dried up. The spores showed no signs of growth, and were surrounded with masses of bacteria and micrococci. In the closed cells, the spores were swollen, and some of them presented minute protrusions from the sides, as if due to commencing growth. As in the open specimens bacteria were abundant. After 48 hours the processes had become distinct and were about twice the length of the spores. Subsequent examination showed no further development, the bacteria present apparently preventing growth.

Experiment 2. *Cell cultivation with vitreous humour.*—Vitreous humour was used in the place of the aqueous, the hairs being taken from the same case, and the experiments were similarly conducted. Five in all, one open and four closed. Placed in the incubator at 23° C., swelling and budding of spores took place within 48 hours, and in 80 hours buds had grown out into distinct mycelial filaments. The fluid, however, contained very numerous micrococci, bacilli, and some triple phosphate crystals, which obscured

the growth. No further growth took place during the eight days in which the preparations were under observation.

Experiment 3. *Cell cultivation with Gelatine peptone.*—Gelatine peptone, as suggested by Koch, but with a larger portion of gelatine, was used in the place of aqueous and vitreous humours, as being more easily obtained, sterilized, and more uniformly solid. A small portion of the jelly was cut out and placed on a cover-glass with a ringworm hair on its surface. The cover-glass was then inverted so as to form the roof of a putty cell, air being admitted by a narrow passage. Two preparations were put up in this way and two closed. After 24 hours in the incubator at 23° C. spores were seen to be swollen in all the specimens, and in the closed cells they had begun to develop buds. After 72 hours these buds had elongated into distinct mycelial filaments, which were longest towards the end of each hair where the jelly had accumulated. The open specimens contained micrococci and bacteria, and had shown no further sign of growth. On the sixth day the mycelium had extended into long filaments, showing septa in places.

Experiment 4.—Six more specimens were mounted, all in closed cells as before. Swelling and budding took place within 48 hours. On the third day mycelial growth was distinct in four. One specimen had dried up ; in the other, bacteria had developed and obscured the spores.

The mycelium became septate during the next four days, but as the fluid gradually evaporated, growth ceased, and by the ninth day all were dried up.

Experiment 5.—Six more specimens were prepared in the same manner. Growth took place in all within 72 hours. On the fourth day oil from the putty had mixed with the fluid of the jelly in three, while the remaining three had dried up.

Experiment 6.—At this point putty cells were given up and hollow glass cells, circular and oval, were used instead.

Hairs from the same case were placed at the bottom of the cell and completely covered with the gelatine peptone. Cell was closed with a cover-glass. Three specimens were placed in the incubator at the temperature of 23° C. In 24 hours the spores had swollen and begun to bud. In 48 hours distinct filaments were growing from sides of the hairs, chiefly towards the ends. Specimens were then left at room temperature, and on the fourth day filaments had grown twice the length, and showed septa. Isolated spores, which had been separated from the hair, had also produced filaments. On the sixth day contents of filaments were becoming granular, and highly refractile spaces began to appear near the ends, in the midst of the protoplasm. In places two filaments or more were seen arising from one spore. The protoplasm next became aggregated in the centre of the filaments, and further growth ceased. Frag-

ments of jelly containing these bodies were transferred to fresh slides and gelatine peptone, but no growth took place from them.

Experiment 7.—Ten specimens were prepared in a similar manner to the last mentioned, with uniform results in every case. Growth ceased before formation of definite fructifying organs.

Experiment 8.—Seven new specimens from a fresh case of typical ringworm were prepared as before and placed in the incubator at 24° C. After 24 hours spores were pear-shaped. In these specimens several isolated spores were watched from day to day. In 48 hours the buds had elongated into filaments, no bacteria or adventitious fungus having appeared in the meantime. In three of the specimens growth ceased on the sixth day, but in the remaining four, which had a less amount of peptone, growth extended to the margin of the jelly, branching freely, and finally sending off twigs at an angle of 45°. Some filaments presented pear-shaped enlargements at their ends. During the next three days these enlargements underwent no further change, but the other terminal filaments commenced to form basidia, sterigmata, and chains of spores in a manner similar to *Penicillium*.

Some of the spores, when removed to fresh gelatine peptone, grew into exactly the same forms of filaments and fructification. They also produced when placed on the human skin beneath a watch-glass fixed by plaster, a crop of itching papules on the third day, and these about the sixth day coalesced to form an erythematous patch, the centre of which gradually faded and desquamated, while the margin spread centrifugally, like a typical patch of ringworm. After washing the surface, scales of epidermis were removed from the margin, and on soaking in liquor potassæ, were found to contain numerous spores, identical in appearance with *Trichophyton tonsurans*.

The *second* generation of spores also produced a typical patch of ringworm, which contained fungus.

Experiment 9. *Cultivation in tubes.*—Twelve tubes, six with hairs at the bottom of the tube, six with hairs floating on the surface of the gelatine peptone. The tubes had been sterilized with care by heating in the flame of a spirit-lamp to dull redness and then plugged with wool. In 24 hours spores in both sets were swollen, pear-shaped, and some had short filaments. During the next day mycelial growth continued. On the sixth day the hairs on the surface had begun to throw up whitish aerial hyphæ, which in two days developed abundant spores.

The spores on the submerged hairs produced very long filaments, the protoplasm of which began to become granular and aggregated in places about the seventh day, then ceasing to grow.

Healthy hairs submerged and floating in the same way showed no results.

Experiment 10.—Spores were removed from the fructifying

hyphæ of the previous experiment, and planted in fresh tubes in a similar manner. They grew into mycelium, which fructified exactly as in Experiment 9.

These experiments have been repeated several times with uniform results.

Life-History.

A. Spores as met with in ringworm hairs are small, round or ovoid bodies, which vary in size from 3 μ to 7 μ, and are highly refractile in appearance. They are arranged in lines in the substance of the hairs, while on the surface they form a thick coating obscuring the mycelium from which they spring. (Plate VII. fig. 1*a*.)

B. 12 *hours' cultivation.*—After 12 hours the spores become swollen to three or four times their original size. Their contents are more hyaline and less refractile, and at one or more points of the circumference a minute protrusion appears, making the spore pear-shaped. (Fig. 1*b*.)

C. 24 *hours' cultivation.*—In 24 hours the protrusion becomes elongated into a retort-shaped body. In many cases a distinct constriction marks the spot at which the filament arises from the spore. (Fig. 2.)

D. 48 *hours' growth.*—In 48 hours some of the filaments had reached a length of 0·7 to 0·9 mm., becoming more or less tortuous. (Fig. 3.)

E. *Third day.*—During the third day growth of filaments and twisting continues.

F. *Fourth and fifth days.*—During the fourth and fifth days the filaments increase in length and branching takes place. No other change.

G. *Sixth, seventh, and eighth days.*—By continued branching of filaments a dense network is formed, and in preparations in which entire hairs were placed it was impossible to trace an individual filament from spore to termination. (Fig. 4.)

This, however, we have done in specimens in which isolated spores have been sown. At this stage, in portions of the mycelium, the protoplasm shows in its centre brightly refractile spots varying in size, and septa are seen immediately above the point of branching. (Fig. 5.)

H.—The end of some of the filaments show bulbous and pear-shaped enlargements, but these do not in any case go on to spore formation.

I. *Aerial hyphæ and fructification.*—As soon as the filaments reached the margin of the jelly and were exposed to air they divided into two or three short branches, on the extremities of which a basidium and sterigmata were developed. (Fig. 6.)

These spores in size and appearance resemble those of ringworm.

In some instances the filament ends in a single chain of spores instead of the usual brush.

K. *Second generation.*—Spores taken from the fructifying growth of the first generation, when placed in fresh cells, swelled and grew in exactly the same way as those derived from ringworm patches. Spores, when removed from the fructification of the second generation, produced, when planted on the human skin, a typical patch of ringworm.

Remarks.—One of the main difficulties which previous observers have had to contend with in their attempts to determine the botanical position of the ringworm fungus, has been the frequent development of adventitious fungi on and in the medium used for the cultivations.

In order, therefore, to obviate this difficulty it appeared to us necessary that the medium used for cultivation should possess the two following properties:—1. Perfect sterilization. 2. Sufficient consistence to retain spores in a fixed position for continuous observation.

1. The gelatine peptone was sterilized by boiling it ten minutes daily for a week. The cells and cover-glasses were heated in the flame of a spirit-lamp to dull redness. The forceps, needles, &c., were heated also. The only opportunity for accidental entry of germs was during the brief interval of transferring to the cells the gelatine and ringworm spores from the closed tubes in which they were kept.

In our earlier experiments with aqueous and vitreous humours we found, like other observers, that the growth of the fungus was interfered with by the presence and rapid development of micrococci and bacteria. We therefore discarded these media for the gelatine peptone, which could be more easily and thoroughly sterilized.

2. In our next experiments with spores placed on the surface of gelatine peptone, we were unable to exclude the possibility of the simultaneous deposition of spores from the air in which the jelly was exposed, nor could we follow the growth of individual spores after about 48 hours. However, by growing the spores entirely imbedded in the substance of the jelly, we were able to watch from day to day the gradual alteration in the shape of the spores, and the subsequent growth of mycelium from them. In fluids, on the other hand, the diffusion which takes place causes a complete intermixture of the accidentally introduced fungi with the growth derived from the spores implanted, while in the jelly the growth from each centre retains a fixed position. If, then, the original spore was a ringworm spore, the growth which we have traced from it to fructification must belong to the same plant as that causing the disease.

With the exception of the ringworm spores, and any accidentally admitted with them into the cell, adventitious fungi can only enter from the margin, where they can be easily detected and removed.

In control experiments with healthy hairs no fungoid growth at all took place, and many specimens remained absolutely barren, while in others a few stellate masses of *Penicillium* and *Aspergillus* made their appearance at the margin. When a portion of a ringworm hair crowded with characteristic spores was placed in the incubator, the mycelial growth sprouted luxuriantly from all parts of its surface and soon formed the dense network described. Isolated spores when scraped from a typical ringworm hair (first proved microscopically) germinated and grew in the same way as those attached to the hair. The figures of this commencing growth will be seen to agree with those of Grawitz, Atkinson, and Thin. It is only in the further development of the fungus that our results are different to these authors. In nearly all our cultivations the temperature of the incubator was maintained at about 23° to 24° C., the growth of the ringworm spores being sufficiently free and the stages of development somewhat prolonged so as to allow more easy observation.

Though the fungus germinated at from 35° to 38° C., the greater number of the preparations were spoiled by the development of bacteria. The premature drying up of the jelly led us after several trials to fix the limit of heat at 24° C. When the temperature fell below 10° C., the growth of filaments ceased and no fresh spores germinated.

Some of the experiments of previous observers for the object of comparison :—

1. Neumann, about 1871.
2. Grawitz, in 1877.
3. Atkinson, in 1878.
4. Thin, in 1881.

Neumann* used the following method. On a glass slide were cemented two parallel slips of glass, on which was laid a cover-glass with a drop of nutrient material on its under surface. The cover-glass, as well as the slide, was moistened with pure water. The objects to be cultivated were placed close by or on the surface of the nutrient material. To purify the cover-glass and slide, they were washed carefully, rubbed dry with writing paper, and finally bathed in ether and alcohol.

As media, Neumann used egg-albumen alone, or in combination with sugar of milk, with or without tartrate of ammonia; tartrate of ammonia and sugar of milk; also paste, starch, phosphate of

* Arch. f. Dermatol. u. Syph., 1871. 'Lehrbuch der Hautkrankheiten,' 1871.

ammonia, phosphate of potash and soda, phosphate of lime, sulphate of quinine, sulphate of magnesia, and glycerine alone or variously combined and frequently with the addition of organic acids, especially citric. These substances had been sterilized, with the exception of albumen, by being kept in a powdered state for a long time in absolute alcohol. Albumen was used only after its freedom from fungi had been ascertained by some days' observation.

"The results of my experiments confirm the clinical observation of Hebra as to the origin of *Herpes tonsurans* and *Favus* from one organism, viz. *Penicillium*. In some cases I also demonstrated *Trichothecium* as the cause, but never succeeded in obtaining *Aspergillus*."

Neumann's results were obtained after cultivations extending over weeks and months.

Grawitz * took great precaution to sterilize his slides and all the apparatus used after the manner of Brefeld, that is by boiling or heating to redness. One or two drops of the medium were placed on a slide mixed with the spores to be grown, and covered with a watch-glass to keep off dust and foreign spores. These preparations were placed on a stand under a bell-glass.

The medium used was gelatine dissolved in sufficient boiling distilled water to form when cool a trembling jelly, and slightly acidulated with lactic or citric acid, to check development of bacteria. He also used an acid solution of meat extract.

He noticed germination of spores and formation of branched filaments from them, but as will be seen from his figures, the subsequent mode of growth differed in the three experiments in which the fungus came from different sources.

Atkinson† used cell-cultivation. A glass ring fastened with Canada balsam on a slide formed the cell, at the bottom of which a drop of distilled water was placed to secure moisture. A small quantity of the nutrient material with the fungus sown in it was placed on a cover-glass, this was inverted to form the roof of the cell and kept in position with oil. The oil, water, and nutrient fluid were sterilized by boiling, and the cell and cover-glass were made scrupulously clean.

Pasteur's fluid, with or without sugar, decoction of horse-dung, aqueous humour, gelatine, currant jelly, and meat infusion, were used, but orange juice seemed to be the most suitable.

In the majority of cases the cell remained quiescent. When successful, growth begins in 24 to 36 hours, or several days. The spores swell, but form filaments, which spring medusa-like from the hair, branch, form septa (third day), and become bulbous at the ends and throw off short sporangium-bearing hyphæ. On the fifth day

* Virchow's Archiv, lxx. (1877).
† New York Medical Journal, 1878.

hyphæ and mycelium become vacuolated, sporangia show "aggregations of protoplasm, the future spores, and occasionally bud." Sporangia were most frequent in under-fed cultivations.

Atkinson believes *Trichophyton* to be a *Mucor*, presenting some differences from *Mucor mucedo*.

Thin* used cells, the hair being placed on under surface of the cover-glass and a drop of fluid placed over it, sometimes so as to cover it, at others only to moisten it. To prevent evaporation a ring of damp blotting-paper was put at the bottom of the cell, which was then kept in an incubator at 92° F. to 98° F. (33·3° C. to 36·6° C.), most usually 96° F. to 98° F. (35·4° to 36·6° C.). He also carried out mass cultivations in protected flasks, on the surface and in the deep. No mention made of sterilization.

Aqueous and vitreous humour, the latter chiefly in successful experiments. Several other fluids were used but with no success.

In cells, spores elongated after a few hours and formed mycelium during two following days, which ceased to grow after having attained a very moderate length, spore formation soon taking place. In flasks, similar results. Bacteria appeared in all cases, adventitious fungi frequently avoided (in 9 out of 12).

Experiments.—Three cells, twelve flasks, in eight of which *Trichophyton* developed. In one case, after being at room temperature in flask from April 20 to May 3rd, it had grown only as much as two days in the incubator. "Growth observed consisted in a development of mycelium from spores, and in the formation of spores within the mycelium, as is portrayed in the drawings. No organs of fructification were observed." Hairs which had been immersed in water for six days, or which had been submerged in vitreous humour showed no sign of growth. Thin's conclusions are, i. That *Trichophyton* is not one of the common fungi. ii. That it can be cultivated artificially when moistened with vitreous humour. iii. When covered with vitreous humour it does not grow.

Remarks.

In comparing the above-described experiments, we notice that Neumann's method, though giving results which coincide with our own, is open to the objection that adventitious fungi could find their way by means of the air to the medium in which the cultivation was then taking place, as his cells were not closed and had to be frequently removed from the incubator for purposes of observation. The long interval which elapsed before growth took place also rendered it more probable that the various fungi observed by him were adventitious.

To Grawitz we are indebted for the idea of using gelatine as one of the constituents of our medium. The difference between

* Proc. Roy. Soc., 1881.

his results and ours may possibly be due to the acidity of his medium. We can offer no other explanation of the great differences between the three specimens which he figures.

Atkinson's results, as shown in his first figure, exactly correspond with our own. It is only in the latter stages we differ. The large sporangium-like bodies and lateral buds, which led him to assign ringworm to the Mucors, seem to correspond with the terminal masses described in section H.

In Thin's cultivations, the swelling and budding of spores and the early formation of mycelium agree with the facts previously described by Grawitz and Atkinson, and now confirmed by ourselves. We are inclined, however, to think the appearances which he considers to be spores, are spaces in the protoplasm of the mycelium, filled with highly refractile fluid, as in the longest filaments, which were observed by us for some weeks, these bright roundish spaces gradually enlarged and coalesced, while the protoplasm shrivelled up and disappeared.

Köbner * believes that these so-called spores within the filaments and terminal buds are only oil-globules. In using vitreous humour we found, like Thin, a very abundant development of bacteria, and in proportion to their growth a coincident cessation of that of the ringworm.

Conclusions.

We think that the experiments we have described warrant the following conclusions:—

1. That the spores of *Trichophyton tonsurans* grow freely on the surface, and in the substance of gelatine peptone at temperatures between 15° and 25° C.

2. That the mycelium only will grow on the substance of the jelly, and that the hyphæ require air to produce conidia.

3. That the branching, septa formation, and fructification are identical with those of *Penicillium*.

4. That spores of the second generation reproduce ringworm on the human skin.

5. That outgrowths resembling "resting-spores" appear on some of the filaments.†

* Virchow's Archiv, xxii. (1861).

† We have to express our great obligation to Dr. Maddox for the photomicrographs which he has produced to illustrate this paper.

The power used was a Beck 1-5th, and the amplification was 1000.

IX.—*On a Portable Form of Aëroscope and Aspirator.*

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

(*Read 11th April*, 1883.)

Serious attention to the ordinary and morbific conditions of the atmosphere having, at last, gained a place in the study of such causes as may be supposed to originate or accompany zymotic and contagious diseases in their course, I venture to offer to those interested in such studies a portable form of aëroscope and aspirator combined. It was found capable, with a single aëroscope, of delivering 12 to 16 pints of air by the use of one pint of water. For exhibiting it in action, I have adapted two aëroscopes, the air being drawn through each by one trompe or aspirator. To Dr. Miquel, of the Microscopical Department at the Observatory of Montsouris, in Paris, we are largely indebted for some most interesting articles in the late yearly publications of the 'Annuaire de l'Observatoire de Montsouris,' on the microbes of the atmosphere, and who, by the continued, laborious, and patient study of the air, dust, water, &c., in different localities, reduced to comparative and statistical data, has been enabled to publish separately, a very enlarged, well-illustrated and comprehensive work on this most difficult subject.* I am indebted to Dr. Miquel for considerable information about the simplest and best form of trompe, and I have here adopted in a simple way the form he has so successfully used. Dr. Miquel writes to me that by carefully proportioning the size and length of tubes, and the inflow of the water, a large delivery of air can be secured. In his letter he figures a form he employed in the country: a tank holding ten litres of water being suspended from a stout branch of a tree, to which also the aspirator is fixed, whilst the aëroscope is placed on a tripod set up at a little distance, the water and air passing from them to another tank on the ground; 10 litres of water sufficing to obtain the passage through the aëroscope of 10 cubic metres of air, delivering from 10 to 11 litres per hour. In the form exhibited, the whole is in rather a limited area. The object being to lessen weight and the chance of breakage, bladders are employed as vessels for the water and air collected.

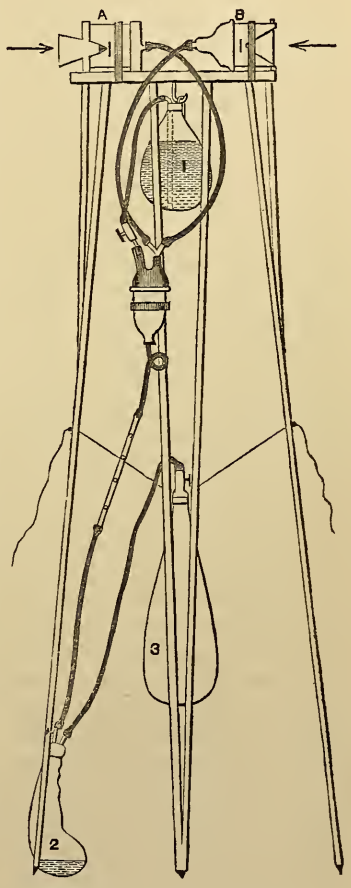
The description of the double form is given, as from it the arrangement of the single one can be readily deduced. I venture to suggest that the plan could be easily utilized in the wards of hospitals, or in the fermenting or other chambers of large breweries when requiring only a temporary or qualitative examination of the air.

* 'Les Organismes vivants de l'Atmosphère, par P. Miquel, Docteur ès Sciences, Docteur en Médecine, Chef du Service Micrographique à l'Observatoire de Montsouris, Paris, 1883, 308 pp, avec figs. See also *infra*, p. 403.

When long examinations are needed, it would be better to use a larger form of apparatus, or at any rate a larger supply of water and some form of meter to register the exact amount of air transmitted in a definite time.

The aëroscope A (fig. 58) is made of a short wide glass tube, brass mounted at each end, and rendered air-tight by indiarubber washers. The parts are separable. The brass tube that holds the short ground neck of the glass funnel inside the cap, supports a bent wire platinum cradle, which carries a thin glass cover, smeared in the centre of the surface towards the funnel, for about half an inch, with glycerine simply, or mixed with gum or glucose. The brass cap at the opposite end to the funnel is pierced by a short metal tube 3-8ths of an inch bore.

Fig. 58.



The aëroscope B is a turned boxwood box, the top unscrewing below the shoulder—one of the boxes sold by chemists made to contain a stoppered short 1-ounce or 10-drachm bottle, the bottle being removed; the bottom is turned out to fit a small pointed conical glass funnel, which is cemented into the box; a small metal cradle, the spring sides of which press against the inside of the box, carries the thin cover-glass smeared with some sticky material, and can be pushed nearer to the point of the funnel or withdrawn as required, being usually placed about the 1-30th of an inch. The distance much depends upon the force of suction of the aspirator. The apertures of the funnel vary from about the 1-50th to the 1-80th of an inch. The top of the box has screwed into it a short metal tube. The aspirator or trompe is a small conical, round-shouldered glass vessel, of about one ounce capacity, open at both ends. On the larger end fits tightly

a laboratory caoutchouc cap with two tubes; into the smaller or neck end fits air-tight a short (1½ inch) ground metal tube.

The two aëroscopes are fixed to a small base-board by two stout indiarubber bands, which pass through two saw-cuts at each end of the board. This board is fastened on the top of a 5½-feet tripod stand. A bladder or a small can containing a certain quantity of water is hooked to the under surface of the board, a flexible siphon tube dips into the water, reaching to the bottom of the vessel, the long leg of the siphon being fitted with a small stopcock with a long conical nozzle. On the lower end of the short metal tube of the aspirator is fitted an indiarubber tube about 9 inches long and 2-8ths of an inch bore; a complete loop is turned on the tube almost close to the metal tube, being held in place by a letter S zinc clasp; the other end of the tube slips over a piece of glass tube of the same bore, about 9 inches long, this forming the index-tube. To the lower end of this glass tube is adapted another caoutchouc tube, which at the opposite end fits on a small stopcock fastened into and passing through the neck of a second bladder, which in use rests on the floor against one of the legs of the tripod. In the neck of the same bladder is a short metal tube, to which is fixed another indiarubber tube that leads to and is fixed on a small stopcock secured in the neck of a third and much larger bladder, suspended by its neck, with stout twine, between the legs of the tripod. The stopcock tube and the second tube are best soldered into a brass tube before it is fixed in the neck of the second bladder; corks do not answer well. The exit ends of the aëroscopes are each joined by caoutchouc tubes to the spread branches of a Y-shaped metal tube, the lower end of which fits into one of the two tubes of the indiarubber cap of the little aspirator, which is held at a convenient height against one of the legs of the tripod by a couple of elastic bands. All the junctions must be made air-tight, and the top of the wooden aëroscope screwed down upon an indiarubber or greased leather washer.

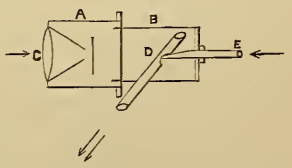
In use, the bladder or small vessel, No. 1, with its siphon, is filled with water, wholly or partially, and suspended from the under surface of the small base-board. The siphon being made to act by suction, and its stopcock turned off, the conical end of the nozzle is at once fitted into the unoccupied tube of the cap of the aspirator. The two other bladders (No. 2 and No. 3) are squeezed empty of air, and their stopcocks turned off and fitted to their respective tubes. The stopcock of the siphon is now opened, so that a drop of water may either drop at the rate, say of 70 to 100 per minute, or else trickle along the side of the little aspirator; this, I think, gives more uniform results than when dropping. The stopcocks of the other two bladders are at once opened. The slow dripping of the water into the looped tube sucks over a considerable amount of air which

has passed through the aëroscopes; the air and water descend together pretty uniformly through the index tube, where the rate of flow is estimated, and pass into the bladder on the floor, the collected air soon passing off by its proper tube into the suspended bladder. This eventually gets filled, or if not quite filled, by the air-pressure, the stopcock of the bladder on the floor is turned off, and slight pressure made by hand. The stopcock is then turned on again and the stopcock of the air-bladder closed, released from its tube, and the air discharged; the bladder is then refixed as before, and the suction of the trompe continued until the water is expended, or as long as required. No. 1 and No. 2 bladders can be easily made interchangeable by temporarily suspending the action of the siphon. The capacity of the large air-bladder being known, and it being filled once or oftener, furnishes a rough estimate of the air drawn over. The time occupied can be also noted. The bladders are rendered flexible by being well impregnated with glycerine.

N.B.—Since exhibiting the double form of aëroscope and aspirator I have constructed an instrument in which the aëroscope and aspirator are *combined* in one. For compactness it has advantages. It was exhibited in action at the Scientific Meeting of the Society on the evening of May 2nd.

The instrument consists of two large brass tubes A, B (fig. 59), which screw together air-tight. A has cemented into it a small glass funnel C, drawn to a point. B is rather longer than A, and has a small brass tube D, open at both ends, soldered obliquely into it. Near the inner end of this tube a portion is cut away, into which freely passes the fine end of another smaller tube E, which is fitted air-tight into the closed end of B, and projects into the tube, so as almost to touch the opposite side. The cover-glass with sticky material is held in a small cradle near to the fine orifice of the funnel. Air enters by C, and water by E, which by gently dropping or escaping by the fine orifice into D, sucks the air through the funnel, and they both together pass off through the outer end of D, to which is attached the looped indiarubber tube, as in the double form. It can be used with the funnel looking downwards or horizontally. To increase the fall and the air spaces between the drops of water passing through the index tube, an upright, about 15 in. high, was screwed to one side of the base board. To the top of the upright was hung an oblong tin vessel (box), into the lower end of which was fixed a small stopcock connected with the projecting end of the tube E, by a short caoutchouc tube.

Fig. 59.



This plan was adopted instead of the bladder with siphon suspended beneath the base board, to hold the water supply. The box can be easily made of a length and size to hold the aëroscope, bladders, and tubes, for easy carriage. I tried suspending a bladder contained in a calico sac, for the sake of lessening the weight in the place of the metal box, but gave the preference to the box for the reasons given. With this simple form of aëroscope I have drawn over 460 measured ounces of air by seven ounces of water. Details have been dwelt upon, so that any one, after obtaining a proper funnel of glass, metal, or metal enamel-covered, can easily construct the rest. Care must be taken to see that the sticky material used does not contain any microphytes, or the results will be falsified. The tripod is not even a necessity, as by a little ingenuity the parts of the apparatus can be otherwise held in position. Careful regulation of the water-flow is necessary to obtain the greatest quantity of air sucked through the aëroscope by the least quantity of water. To increase the length of the fall tube, it was wound round one of the legs of the tripod, but without advantage, as friction appeared to delay the flow. The thin covers with the dust collected are placed down on a clean slide for microscopical examination.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

Mesoblast of Vertebrata.† — O. Hertwig discusses several important points.

1. We have had statements to the effect that the mesoblast has a paired, and others that it has an unpaired rudiment. These conflicting views are due to the fact that some authors regard the median set of cells as belonging to the mesoblast, while others look upon it as part of the endoblast; against this latter it may be urged that the set of cells in question cannot be separated off from the mesoblast, and against the former it may be said that there is no special peri-enteric cell-layer lying below it. In connection with this we observe that some authors regard the notochord as having a mesoblastic origin, but O. Hertwig believes that before long it will be generally allowed that, so long as the notochord is not definitely differentiated, the embryo, in the middle line, is still diploblastic. The dorsal median set of cells should not be called either mesoblast or endoblast, but the names of chorda-endoblast and enteric endoblast should be ascribed to the two parts in this region.

2. Taking next the vexed question of the origin of the mesoblast from the endoblast or ectoblast, we find that an explanation is afforded by the "cœlom-theory," for both endoblast and mesoblast arise by the infolding of a membrane, which primitively bounded the surface of the blastula. In *Amphioxus* the gastrula-formation comes to an end before the endoblast has become more complicated, and then it seems as if the mesoblast arose from the endoblast. But in the higher

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

† Jen. Zeitschr. f. Naturwiss., ix. (1882) pp. 247–328 (5 pls.).

Vertebrata the lateral mesoblastic masses begin to be developed before the gastrula-invagination is completed, and here it seems as if the mesoblast arose from the ectoblast. However, in both cases the final result is the same, and we cannot justly speak of any real difference in the genesis of the middle layer.

3. The explanation of the difference of opinion as to the origin of the notochord is partly to be found in the fact that the observers of some stages have examined embryos at a time when the median band passes directly on either side into the mesoblast; and they, therefore, have ascribed a mesoblastic origin to the chord. Others have studied development more particularly at the period when the chorda-endoblast has become separated from the mesoblast and lies above the enteric glandular layer in the form of a thickened band of cells; and they have asserted the hypoblastic origin of the chord.

The following considerations appear to have an important bearing on the questions at issue. (1) Before the notochord becomes developed the embryo is in part bilaminate, consisting of an ectoblast (medullary plate), and of chorda-endoblast which takes part in the delimitation of the enteric cavity. (2) On either side of this portion (median band) the embryo is trilaminate, if we regard the mesoblast as a simple layer, and quadrilaminate if we regard the mesoblast as consisting of parietal and visceral cell-layers, which only become distinctly separated on the appearance of the cœlom. (3) In no Vertebrate does the mesoblast arise by cleavage. (4) The mesoblast is only connected with the bounding cell-layers at the blastopore or at the primitive groove, where all three germinal layers are connected together, and at the two sides of the chorda-endoblast. (5) The mesoblast arises peripherally and extends forwards, backwards, and ventrally; in front of the blastopore it forms a paired rudiment separated by the chorda-endoblast, while behind the blastopore it is unpaired. (6) As the chief portion of the material for the growth of the mesoblast is derived from the cells, which, at the blastopore, or at the primitive groove, pass from without inwards, we are entitled to say that the process of invagination which commences with the formation of the gastrula is carried on into later stages of development. (7) The process by which the paired mesoblastic bands separate from the neighbouring cell-layers and undergrow the notochord to inclose the enteron, may be so far modified that a lamella of cells from the chorda-endoblast may take part in it (Anura).

The author supports the important doctrine that the ingrowth of the mesoblast may be looked upon as an invaginative process of epithelial lamellæ by the following facts: (α) The mesoblast arises as a connected mass from masses of epithelial lamellæ. (β) In all Vertebrates a cleft appears early in the mesoblast which is bounded by epithelial cells, of a cylindrical or cubical form. The parietal and visceral mesoblast are, as is well seen in Elasmobranchs, at a very early stage epithelial lamellæ. (γ) From these there arise true epithelial membranes and glands. (δ) This view is supported by what is seen in *Amphioxus*. (ϵ) The objection that the mesoblast of the Vertebrata arises as a single cell-mass and cannot therefore be regarded as equi-

valent to two epithelial layers, will have no weight for those who remember that in the Chætognatha the mesoblast appears, is lost, and again appears; that in Bony Fishes the nerve-cord is at first solid; or the mode of development of various sensory and glandular organs. Hertwig concludes by entering into a detailed criticism of the remarks of His on the "cœlom-theory" of his brother and himself.

The earlier part of the paper is occupied with the Amphibia—where *Rana temporaria* is taken as the type; in dealing with mesoblastic ova (Elasmobranchs, reptiles, birds, and mammals) the author confines himself to discussing the observations of his fellow-workers, and drawing from them lessons which bear on his general conclusions.

Inversion of Blastodermic Layers in Rat and Mouse.*—A. Fraser finds that in the common grey rat and the house-mouse we find the same arrangement of blastodermic layers as in the guinea-pig. The *decidua* appears to differ in the mode of its formation from that which ordinarily obtains, and the very early, rapid, and voluminous formation of its solid mass appears to have some close and constant relation to the peculiar inversion of the blastodermic layers which is found in these rodents.

Spermatozoon of the Newt.†—Mr. G. F. Dowdeswell describes a minute barb at the extreme point of the "head" of the spermatozoon of the newt, which has hitherto escaped notice. It is 2 μ long and 1·5 μ broad. A similar structure was not found in other spermatozoa. It is suggested that the function of the barb is to attach the spermatozoon, and enable it to penetrate into the ovum in the early stages of fertilization, as has been shown to occur by Fol and others.

Development of the Red Blood-corpuscles.‡—W. Feuerstack finds that nucleated red blood-corpuscles arise from colourless blood-cells; the forms most closely allied to them are the ordinarily spherical coloured cells with an often disproportionately large nucleus—the so-called hæmatoblasts. Among these we meet with forms which present us with a series of intermediate stages between the ordinary red blood-corpuscle and the typical smaller hæmatoblasts with a proportionately large peripheral nucleus. The hæmatoblasts are derived directly from the colourless cells, in which the nucleus is much smaller. In Amphibia (e. g. *Triton*) and, to a less degree, in fishes, the formation of the red blood-corpuscle is not so regular as in birds, and we find therefore in them a much greater variety in the size of the hæmatoblasts.

The answer to the question where this blood-formation goes on is based on the supposition that we must look for it at such points as those in which we find the largest number and youngest stages of forms intermediate between coloured and colourless cells. In the pigeon these points are the osseous medulla, the spleen, the portal system, and the medulla of the young quills of the feathers.

* Proc. Roy. Soc., xxxiv. (1883) pp. 430-7.
† Quart. Journ. Micr. Sci., xxiii. (1883) pp. 336–9 (1 fig.).
‡ Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 136–64.

In the frog they are the osseous medulla and the spleen, but in this animal the differences between the blood of these and other parts is not so well marked as in the pigeon. The osseous medulla appears to be the most important factor in the modification of the development of the colourless blood-elements, but it must be remembered that, without this medulla, there are developed colourless cells, which, taking up hæmoglobin, become converted into red blood-corpuscles. In some of the cases where the medulla is wanting or reduced we find that the spleen is of considerable size (eels); at the same time, this organ may be extirpated and fresh cells be still produced.

No unimportant part appears to be played by the lymph-sinuses, and attention must be given to such causes as are due to the slowing of the blood in some of the organs in which white corpuscles seem to be most largely developed.

Origin and Destiny of Fat-cells.*—Some light is thrown upon the problem of the origin and destiny of fat-cells by the observations of Mr. S. H. Gage upon those of *Necturus*.

In the subcutaneous connective tissue of this creature the Microscope revealed the presence of fat-cells in all stages of growth: large branched cells with one or more fat-drops; cells containing one or two small fat-drops and a large one; and some large unbranched cells entirely gorged with fat. The pigment-cells were sometimes partly gorged with fat, and some small round or oval cells also contained fat.

Thus it would appear that, as maintained by Virchow, Frey, Klein, and others, fixed or branched connective tissue corpuscles may become modified into fat-cells, and also, as asserted by Czajewicz, Rollett, and others, migratory corpuscles may become quiescent and turn into reservoirs of fat. After a *Necturus* has been kept upon sparse diet for some time, the adipose tissue shows but few gorged cells, many transitional forms, and a greater proportion of branched cells without fat, thus proving that the fat-cell is simply a store of food, and that, when their store is used, the cells revert to their primitive condition of branched or unbranched cells.

Embryology of the Milk-glands.†—G. Rein summarizes the results of his extended researches on the development of the milk-glands. The same type of formation was found in all the species investigated. Gegenbaur has maintained that the majority of mammals have their teats formed by an upgrowth of the area in which the lactic glands are developed; but that in ruminants there is another type, the glandular area forming a depression, the walls of which grow up around it into a teat. Rein, however, demonstrates that the ruminants conform to the usual development. His investigations may be summarized as follows:—

The first trace of the milk-gland appears very early, usually when the visceral clefts are closed; in man, during the second month. The gland first appears as an ingrowth of the epidermis. The connective

* Amer. Natural., xvii. (1883) p. 444.

† Arch. f. Mikr. Anat., xxi. (1882) p. 678. Cf. Science, i. (1883) p. 53.

tissue of the nipple is next formed; the teat may be developed early (ruminants, horse, &c.), or at the end of fœtal life (man). Next secondary outgrowths arise from the primitive epidermal bud, as many as there are ducts in the adults. At this period the differentiation of the stroma from the mesoderm begins. Most of the primitive ingrowth disappears, a little remaining as the common orificial duct. The secondary epithelial growths, on the other hand, grow farther, become tubular, branch, and finally form the ducts (sinus and ducts proper) and the acini. In the human fœtus all the parts of glands are developed by the time of birth. The development is according to this same plan in all the animals investigated, comprising species of Primates, Insectivora, Carnivora, Ungulata, Glires, and Didelphyda. The so-called Montgomery glands are rudimentary milk-glands. The view advanced by Creighton and Talma, that the acini are developed from the mesoderm, is incorrect. The milk-glands cannot be regarded as modified sebaceous glands, but are organs *sui generis*.

Caudal End of Vertebrate Embryos.*—In his studies on the development of *Melopsittacus*, Braun observed that a constriction is formed around the end of the tail which leads to the construction of a terminal knob, connected by a thin stalk with the base of the tail. Into this *nodulus caudalis* the chorda and medullary tube originally extend; but they afterwards withdraw from it, leaving the nodulus, a ball of mesoderm covered by epithelium, to be finally resorbed. This discovery led Braun to search for similar structures in mammals, and he now publishes his results. His investigations were made principally on sheep embryos, and observations were also made on those of other species. He finds an homologous structure, having, however, more usually a thread-like form. In sheep it may be readily seen in most cases when the tail is from 1·5 to 3 mm. long. His general results are:—

1. The tail of mammalian embryos consists of two parts, an anterior or basal vertebrate; and a posterior invertebrate and smaller portion, which, from its usual form, may be called the caudal thread. 2. The vertebrate portion may be partly or wholly imbedded in the body (internal tail), and terminates at the sacral vertebræ in front; the division of the tail which protrudes is the external tail. 3. The caudal thread contains originally the terminal portions of the chorda dorsalis, the medullary tube, and the caudal gut (*Schwanzdarm*). These are the first parts of the thread to be resorbed; the rest disappears later, the epidermal covering lasting longest. 4. The caudal gut is a rectal cæcum; before it is resolved it breaks up into single parts, of which those in the tip of the tail endure the longest. 5. The chorda dorsalis projects beyond the last vertebra, its ending being often forked or contorted. 6. The medullary tube reaches to the tip of the tail or the base of the caudal thread, and its posterior end is probably resorbed.

Braun further believes that he has found traces of a neurenteric

* Arch. Anat. u. Physiol., Anat. Abth., 1882, p. 207. Cf. Science, i. (1883) p. 261.

canal in sheep embryos. He adds a discussion of the tail in human embryos. Finally he homologizes with the embryonic caudal thread, the soft coccygeal appendix of *Inuus pithecus*, and similar structures found abnormally in the chimpanzee, orang-outang, and man, and gives citations to prove that the caudal thread exists in human embryos.

Influences which Determine Sex in the Embryo.*—Prof. E. Pflüger publishes at length an account of experiments, performed with the greatest care, with the object of throwing light upon some of the most prominent of the obscure problems of the physiology of generation. He made use of frogs in his experiments; many hundreds of the creatures were obtained from various neighbourhoods, and were maintained while under observation under conditions made as nearly normal as possible.

The first question dealt with is: Does the concentration of the spermatic fluid of the male influence the sex of the offspring? Much care is necessary in handling frogs' eggs, for they are exceedingly susceptible of mechanical injury. The pair of frogs are parted during the sexual embrace, and therefore at a time when the products of the generative organs are presumably ripe, the animals are killed, and the spermatic sacs of the males are emptied into a watch-glass. A second watch-glass, filled with water, is impregnated with spermatozoa by dipping into it the tips of the fine pair of scissors which has just been used to cut open the spermatic sacs and has, therefore, some of their contents clinging to it. The dilute spermatic fluid of the second watch-glass was often further diluted from ten to twenty volumes, and from these new mixtures fresh quantities of water in watch-glasses were impregnated by the transference of a film of fluid clinging to the scissors' tips. Into these watch-glasses, filled with the fluid of a single male in different states of concentration, there were allowed to glide some of the eggs of the female taken from the right uterus.

The experiments established two facts, first, the fertilizing power of the spermatic fluid was not diminished by dilution, all the ova were fertilized in each observation; second, dilution of the male fluid had no effect on the sex of the frogs which came to maturity after the artificial fertilization.

In young frogs there are three varieties of sexual character, male, female, and hermaphrodite. The hermaphrodites become finally either male or female, but in their earlier stages they have the sexual organs of the female only; in those which are finally to become males, the testicles gradually develop round the ovaries and the latter are resorbed. This apparent numerical predominance of the female in early stages of the fuller formed frog has led some investigators astray.

The author finds that no Batrachian egg segments without previous fertilization. The fertilizing power of the male fluid diminishes greatly and progressively after the season for sexual union.

* Pflüger's Archiv, xxix. Cf. Amer. Natural., xvii. (1883) pp. 441–2.

It is impossible to produce offspring by the union of the male and female products of two different Batrachian species, though segmentation of the egg, frequently of abnormal type, may be started by this artificial union.

Sense of Direction in Animals.*—The remarkable faculty which cats, dogs, pigeons, and other animals possess, of returning in a straight line to a point of departure, has awakened much curiosity on the part of naturalists. Some refer it to instinct, some to intelligence similar to that of man, some to an internal mechanism which makes the animals simply automata; but none of these attempted explanations do anything towards solving the mystery. Wallace supposed that when an animal is carried to a great distance in a basket, its fright makes it very attentive to the different odours which it encounters upon the way, and that the return of these odours, in inverse order, furnishes the needful guide. Toussenel supposes that birds recognize the north as the cold quarter, the south as the warm, the east (in France) as the dry, and the west as the moist. Viguier, in the 'Revue Philosophique,' publishes an original memoir upon the sense of orientation and its organs, in which he attributes the faculty to a perception of magnetic currents.

Cerebral Homologies in Vertebrates and Invertebrates.†—In this very interesting contribution Prof. Owen distinguishes between the neurœsophageal and the hæmœsophageal aspects of an animal's body; and speaks of the side of the body of a cuttle-fish denoted by the neurœsophageal ("subœsophageal" so-called) brain-part, with the chief nervous extensions therefrom along the trunk, as the "neural aspect," and the opposite side to which the hæmœsophageal ("supra-œsophageal") brain-part has been turned by the course of the gullet, as the "hæmal aspect." What is usually called the upper surface in Invertebrates is the "hæmal" one, and the lower the "neural" one. So the heart in man indicates the "hæmal" aspect, the myelon the "neural" part of his body, as in the animals below him whether vertebrate or invertebrate.

Attention is directed to the fact that in Invertebrates there is not the same concentration of sensory organs as in Vertebrates, and that among the latter themselves we find (e. g. Cyprinoids) the olfactory separated by long cords from the optic ganglia. The "subœsophageal ganglion" is regarded as the homologue of the medulla oblongata, or "so much of that myelencephalous tract as may be in connection with the trigeminal and hypoglossal nerves," or, in other words, with the part that affects the vertebrate mouth. The ear in Orthoptera is found in the first pair of legs. Basing himself on these and other facts, the author concludes that "the collective neural centres and their intercommunicating tracts in Invertebrates are the homologues of those centres and tracts called 'brain and spinal cord' in Vertebrates, and that such 'neural axis' marks, in both grades of the

* Chron. Iudustr., Nov. 2, 1882. See Journ. Frankl. Institute, cxv. (1883) p. 314.

† Journ. Linn. Soc. (Zool.), xvii. (1883) pp. 1–13.

animal series, the same position in the body, and the same local relations to the vascular centre and the alimentary canal." The foremost portion in Arthropods is simply displaced by the course of the gullet in order to open by a mouth on the neural aspect of the body. Where, as in Vertebrates, there is no œsophageal obstacle, the main cerebral centres become more closely approximated. In fact, the difference between the central nervous system of Vertebrates and Invertebrates is to be found in the "altered relation thereto of the gullet and mouth."

B. INVERTEBRATA.

Apparently New Animal Type (Trichoplax adhærens).*—Prof. F. E. Schulze records the discovery of an animal quite different from anything hitherto known. It was observed in the sea-water aquarium of the Zoological Institute at Graz. It is a thin plate about 0·02 mm. thick, and only a few millimetres in diameter. It constantly changes its form. It is translucent, and greyish-white in colour. At rest it is rounded in outline, but may draw itself out into a long thread, which may so curl and twist that it recalls a Persian or a Turkish letter. The movements are usually so slow as to be barely perceptible as the animal creeps along upon its under surface.

Microscopical examination shows that the whole surface of the body is ciliated. Close under the upper surface is a layer of highly refractile balls from 5 to 8 μ in diameter, and distributed pretty evenly. Besides these there are other balls nearer the under surface, which seem to be essentially different from those first mentioned. There is no indication of internal organs, nor of only bilateral or radiate symmetry: the organism is uniaxial. Schulze names it *Trichoplax* (the ciliated plate), with the specific name *adhærens*, because it clings so closely to the surface on which it is moving.

Such an organism one would expect to find related to the Protozoa; far from it, for two different epithelial layers of cells form its upper and lower surfaces, and contain between them a fully developed layer of connective tissue. The upper epithelium is composed of large, flattened, polygonal cells; the lower epithelium, on the contrary, is composed of cylinder-cells, whose outer ends form a mosaic of small polygons, but whose inner ends terminate in processes that are lost in the connective tissue. This last, forming the middle layer of the body, consists of spindle-shaped and branching nucleated cells, which are probably contractile, and are imbedded in a hyaline basal substance. The balls above mentioned are contained in large cells. There are, then, three layers, which from their relations would naturally be compared with the ectoderm, mesoderm, and endoderm of other metazoa: but the justification of this comparison must await a knowledge of the development of the organism.

Professor Schulze speculates as to the relationship of the creature, but finds it impossible to assign it to any known class. Although it has been watched for a year, no sign of metamorphosis or of repro-

* Zool. Anzeig., vi. (1883) pp. 92–7 (2 figs.).

duction has been observed; but he thinks it possible that it may have multiplied in the autumn by division.

Mr. C. S. Minot thinks* that the animal bears a strong resemblance to a sponge-larva.

Chlorophyll of Animals.†—In the introduction to this very important paper on the morphological and physiological significance of chlorophyll in animals, K. Brandt resumes the results of his earlier investigations, in which he set himself to demonstrate that chlorophyll formed by animals is never found; that, where present, it is due to the presence of unicellular algæ; and that the animal hosts may be nourished owing to the assimilative power of these algæ.

Commencing with an account of the "yellow-cells," he gives a list of the animals in which they have been observed—Foraminifera, Radiolaria, Flagellata, Ciliata, Sponges, all three groups of Cœlenterata, two Echinoderms, one Bryozoon, three Turbellaria, and one Annelid. The algal nature of the yellow-cells is next discussed, the views of Geddes criticized closely, and the algal nature upheld; the organization of these bodies is discussed in detail, and the characters of the different forms found in various animals described and criticized.

This section of the essay concludes with a discussion of the question, to what group of algæ these yellow-cells belong, and the result is arrived at that they are the resting-stages of various marine algæ, and especially of the Melanophyceæ. The further detailed result may be left to professed physiologists.

After some account of the pseudo-chlorophyll bodies, the author passes to the symbiosis of animals and algæ; animals may live independently of algæ, and algæ of animals, but the Radiolaria appear to be very dependent on their guests. After having convinced himself of the fact that yellow-cells can nourish their animal hosts, Dr. Brandt turned to the mode in which this is effected; in the Collozoa he found, after treatment with iodine, numerous small granules of starch in the protoplasm of the animal. As these were specially numerous on the outer surface of the yellow-cells and in the neighbourhood of completely intact yellow-cells, and agreed in all their important characters with those found in the cells, they may fairly be regarded as assimilative products of the yellow-cells that have become free. From these observations it is clear that the assimilation products of the living yellow-cells may partly serve the animals, and it is possible that in animals the assimilative processes of the alga go on more actively, inasmuch as they are there more richly provided with carbonic acid than they are when free in the water. In fine, the author has no doubt that the guests do provide starch for their hosts.

Some experiments have been made on the production of oxygen which have led to the following conclusions:—Alga-containing Actiniæ, if brought from diffused into direct sunlight, exhibit no irritation, if means are taken to prevent a rise in temperature. If the

* Science, i. (1883) p. 305.

† MT. Zool. Stat. Neapel, iv. (1883) pp. 191–302 (2 pls.).

Actiniæ are gradually heated from 26–27° to 35–36° C., the movements of alga-bearing or alga-free Actiniæ become more lively, and this is true whether the change is due to sunlight or to artificial heating, with careful exclusion of the light. If alga-bearing Anthozoa are subjected to direct light they are killed, and this not because of the great production of oxygen or the influence of the light, but in consequence of the heating; the production of oxygen does not seem in any way to affect the result.

All alga bearing Actiniæ throw off a number of yellow-cells when subjected to heat; treatment at 30° for some time or at 35° for a shorter resulting in the presence in the surrounding water of irregular brown masses, which contain a large number of yellow-cells, which were still completely capable of development or of assimilation; and this even obtained when the Actiniæ were themselves killed.

Yellowish-green and yellow *Zooxanthellæ* are only found in animals living on the surface of the sea (Radiolaria, Globigerinæ, Siphonophora, Rhizostomidæ); brown cells in those which live at a slight depth, and red algæ in sponges, which live somewhat deeper (15–35 m.).

Division of Lower Invertebrates.*—C. Bülow gives in a collected form some of the scattered information and theories which affect the question of the apparently voluntary division, with subsequent regeneration, of Cœlenterates, Echinoderms, and Worms, and gives some unpublished observations as to regeneration in the Gephyrea.

Examining some living specimens of *Phascolosoma vulgare* and *Aspidosiphon muelleri*, he removed from five of the former and three of the latter a portion of their proboscis; the œsophageal ring was separated from the rest of the body, as well as the tentacles, the mouth, part of the retractor muscles, &c. In from three to five weeks all the lost parts were replaced, and the only apparent difference was to be found in a brighter colour and a greater transparency.

Mollusca.

Chromatophores of Cephalopoda.†—R. Blanchard finds that the chromatophore of the Cephalopod does not differ in the general characters of its structure from that of Fishes, Batrachia, or Lizards (*Chamæleo*); it is a simple connective-cell charged with pigment, and possessing to a high degree the power of protruding amœboid processes from the centre of its amorphous central mass. All the activity is seated in the chromatophore itself, and the surrounding tissues take no part in accomplishing its movements; in fact, it may be well compared to an amœba, charged with pigment, and independent of the dermis which incloses it.

This amœba, however, is under the influence of the nervous system, as the observations and experiments of Brücke, Bert, and others have already demonstrated; but it is not possible to agree with Harting in thinking that the radiating fibres seen in Cephalopods are

* Biol. Centralbl., iii. (1883) pp. 14–20.
† Comptes Rendus, xcvi. (1883) pp. 655–8.

nervous terminations; they are nothing more than mere fibres of connective tissue, which have no connection with the chromatophore. Henceforward the chromatophores of the Cephalopoda will not be allowed to form an exception to the general rule that muscular fibres never become inserted into cells, connective or other, and the whole phenomena of their change in coloration will be brought into association with what is seen in other forms.

Deep-Sea Solenoconcha.*—P. Fischer points out that the molluscan fauna of great depths is characterized by the great abundance of individuals, but the small number of genera and families; among the Mollusca best represented are the Solenoconcha or Scaphopoda, opisthobranch and prosobranch Gasteropoda and Lamellibranchs. The first of these seem to be well adapted for living in the bottom of the ocean; ordinarily without eyes, they capture by the aid of their tentacular filaments the surrounding Foraminifera; they would seem to be present in great numbers, and the best represented species is the *Dentalium agile*, described by Sars from dredgings in the Northern Seas. A gigantic specimen, dredged by the 'Travailleur,' and now named *D. ergasticum*, was, when alive, more than 9 cm. long, and its shell is very thick and solid; another, which was probably still larger, cannot be specifically distinguished from an Italian pliocene fossil, and other cases of the same kind lead to the belief that many pliocene fossils supposed to be extinct still live at the bottom of the Mediterranean. Indeed the pliocene Mediterranean must have had a contour and fauna very little different from that of to-day, though there must have been a great difference in the Southern European sea of the miocene period.

Vascular System of Naiadæ and Mytilidæ.†—In this essay H. Griesbach considers the vascular system and the ingestion of water in some Lamellibranchs. He finds that the peripheral tracts of the vascular system are not closed, but that between the arterial and venous portions there are intercalated spaces without walls or endothelium—that is, lacunæ in the gelatinous tissue. True capillaries are never found, except in the gills of a few forms, among Lamellibranchs. The venous portion of the vascular system is complete, and represents the remainder of the cœlom, while the lacunæ are cœlom *par excellence*. The so-called vesicles of Langer, or mucous cells of Flemming, do not exist as such, but are the true lacunæ. In the interior, as at the periphery, the vascular system is not closed, but it there communicates with the surrounding medium. The fluid circulated in the vascular system is a mixture of hæmal constituents and water. The water enters by the *pori aquiferi*, and passes out through the organ of Bojanus. There is no special water-vascular system, but the ingestion is a constant phenomenon.

After pointing out the present condition of the question, the author gives a detailed account of the work of his predecessors, and then proceeds to adduce facts in favour of the above-mentioned con-

* Comptes Rendus, xcvi. (1883) pp. 797–9.

† Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 1–44 (1 pl.).

clusions. Much of what is of value in his history of the vascular system will be found to be due to his recognition of the fact that, in this question, there is a limit to macroscopical inquiries, and that the assistance of the Microscope is necessary. He has thus been able to make out the great size of the so-called capillary tubes. By the aid of experiment he was able to deprive the heart of the greater part of its blood, and to force on himself the question, whither has that blood gone? and in this to convince himself of the presence of hæmal spaces in the gelatinous tissue.

The blood in the lacunar system would appear to be gradually collected from the most various parts of the body by venous vessels; from the lacunæ of the foot and of the anterior portion of the mantle, it passes into the *truncus venosus*, which lies below the rectum, and opens into the pericardium. The veins are true vessels, with a lining of endothelium, but they are not so highly differentiated as is the arterial portion. Although there can be no doubt that the vascular system of Lamellibranchs is, in all its parts, capable of enormous extension, there does not appear to be any sufficient ground for believing that there is a special tissue at the points where this extension more particularly takes place. For this we must look especially to the presence of lacunar spaces. As to the arrangement of these last, it does not seem possible at present to arrive at any generalizations. The author points out the differences between true capillaries and such lacunæ as those which he describes.

A suitable object for the study of the ingestion is afforded by *Cyclas cornea*, examined by low power, when placed in a watch-glass. The cilia will be found to be in active movement, working at the respiratory cavity from without inwards, and in a reverse direction at the cloacal orifice. Experiments with carmine will, if rapidly performed, make this still more obvious. The author enters into an account of the best way of observing the phenomena, and of the special experiments which he undertook.

The Naiadæ have three *pori aquiferi* in the foot, and by these the water passes directly into the blood; the slit-like pores in *Mytilus* and *Dryssena* lead into a canal-like duct, which is wider in the former than in the latter; in both we find a ciliated cylindrical epithelium surrounding the pore. The duct appears to be nothing more than a lacuna, with which a number of vascular-like lacunæ are connected, and the whole water-tube is traversed by numerous muscular fibrils, to the presence of which the vascular appearance of the lacunæ may be ascribed. The author believes that this ingestion of water is a true part of the respiratory activity of the Lamellibranchs, and he thinks that, of necessity, the action must be a constant or permanent one.

Generative Organs of the Oyster.*—After an elaborate bibliographical account, P. P. C. Hoek investigates the structure of these organs in detail.

He finds that the reproductive organ of the oyster consists of the genital gland, and its efferent ducts, without any accessory organs.

* Tijdschr. Nederl. Dierk. Ver., Suppl. i. 1 (1883) 253 pp. (1 pl.).

The gland is not compact and confined to a definite area, but it extends over nearly the whole of the part which may be strictly called the trunk. Separated from the integument by a delicate layer of connective tissue, it forms a system of ducts which anastomose with one another, and have their inner wall developed into cæcal processes which are set vertically to the surface of the body, and extend into the connective tissue.

The genital products are developed on the walls of the cæca, and spermatozoa and ova are developed side by side in the same cæcum. They appear to arise from epithelial cells which may be considered as the sister-cells of those which invest the walls of the genital ducts. Their prime origin would appear to be ectodermal, and it is a very difficult matter to make out any mesenchymatous portion. As in other cases, a cell is entirely metamorphosed into an egg-cell, while the spermatozoa arising from one mother-cell form a characteristic aggregation. The ducts of the gland communicate either directly or indirectly with a chief efferent duct, which opens at the anterior termination of a cleft which extends along the muscle of the valves.

The organ of Bojanus so far agrees with the genital organ that it is not, as in other Lamellibranchs, compact, but is formed of an assemblage of ducts and cæca, which form a flattened layer of great extent, but of slight thickness. The wall of the cavity into which the products of these two glands open also has an excretory function, and it may therefore be spoken of as the urinary chamber, and its ducts as the ureter. There is no communication between the orifices of the genital and renal organs. The "reno-pericardiac canal" effects a communication between the urinary chamber and the pericardium, and it seems probable that the auricles have some excretory function.

At the time when the ova are laid they are not only fecundated but have passed through the earlier stages of segmentation, but the sperm necessary for this fecundation does not arise from the same oyster. The water which passes over these Molluscs brings from oysters the escaped spermatozoa; some of these pass into the cavity of the mantle, penetrate the generative orifice, and not only make their way into the principal duct, but also into the larger branches connected with it. The oysters of the Eastern Scheldt may have fry in their gills when they are only two years old, but, as a rule, the oysters with fry are older than this, and those of four or five years have the most. Similarly, oysters two years old may produce spermatozoa, but as a rule, these last arise from older forms. As has already been discovered, oysters of one year may develope spermatozoa, and we find in the Eastern Scheldt that the number of oysters which develope spermatozoa is larger than that of those which give rise to ova. The eggs of a mature oyster are, if properly developed, all laid at once; the spermatozoa seem to be evacuated during a longer period. The evacuation of ova appears to exceed that of spermatozoa. Cultivation does not show itself favourable to the procreative capabilities of the oyster. In old examples the liver is much more developed than in younger specimens, and this in correlation with the degeneration of the reproductive organs.

Molluscoida.

Development of Ova in Ascidians.*—A. Sabatier, who has investigated a large number of Ascidians, finds that:—

The ovary is composed at first of nuclei arising from the mesoderm and connected together by a small amount of clear intermediate substances. This structure is seen in the adult in those regions of the ovary in which there is a fresh formation of ova. The ovum arises primitively from one of the corpuscles of this tissue, and this, in which one or two granulations appear to form nucleoli, constitutes the nucleus of the future egg. Around this a layer of transparent colourless protoplasm becomes arranged, and thus the essential elements of the egg are connected together. A delicate membrane, which appears to arise from the intermediate substance of the embryonic connective tissue of the ovary, forms a capsule for the egg. Below this and on the surface of the yolk, cellular elements arise; these are formed in the yolk and not from outside it. Below them and at their expense is developed a second vitelline membrane. The so-called granular cells are, as Kuppfer and Semper have taught, likewise of vitelline origin; the intra-vitelline corpuscles are also not immigrated bodies, but they owe their origin to a concentration of granules within the yolk itself.

Structure of Ovary of Phaliusiadæ.†—L. Roule, after stating that he is able to confirm the accounts given by Fol and Sabatier of the ova of *Ciona intestinalis*, states that the ovules are derived from endothelial cells, which have a protoplasmic layer around their nucleus and an external enveloping membrane; this last becomes the very delicate vitelline membrane, while the protoplasm and nucleus, increasing in size, form the yolk and the germinal vesicle. The ovules may be found at all stages of development and appear to radiate round a centre of formation. We may then see that the germinal vesicle of young ova contains, in addition to the large nucleolus, two or three smaller nucleoli; in larger eggs there are five or six; gradually these approach the periphery, and appear to pass to the exterior. Those that pass into the yolk may be further traced as cells of the egg-covering, and the *testa* thus formed may be looked upon as a remnant of the ovular excretion which has produced the follicle; in some cases the last formed "nuclei" are sufficiently numerous to form a complete layer of the testa, while in others they only produce separate masses. This phenomenon is the cause of variation in the appearance of the ova of different species of Ascidians, and in some cases of different individuals.

Embryonic Development of Salpidæ.‡—W. Salensky finds that in the earliest stages the processes of maturation of the ovum of *Salpa* consists in the shortening of the ovarian pedicle, and in the formation of polar cells which appear before the process of shortening is com-

* Comptes Rendus, xcvi. (1883) pp. 799–801.
† Ibid., (1883) pp. 1069–72.
‡ MT. Zool. Stat. Neapel, iv. (1882) pp. 90–171 (12 pls.).

pleted. This phenomenon leads to the supposition that fertilization takes place some time after the development of the polar cells, and this view is supported by the fact that spermatozoa only appear in the oviduct when that shortening is over. After the ova consist of four parts the follicular cells begin to proliferate, and completely surround the blastomeres, forming the chief mass of the embryonic cells. In connection with the ovarian products there appears an epithelial investment, derived from the thickened portion of the wall of the respiratory cavity, which, later on, separates into an ectodermal and a placental portion, and plays an important part in the formation of the embryo. Cleavage goes on very slowly; the oviduct continues to shorten, and ends by converting the follicle into a saccular structure, to the inner surface of which the cells become attached. As the oviduct contracts, the follicle passes into the cavity of the ectodermal portion of the epithelial outgrowth, and concludes by completely filling it. After the separation of the epithelial outgrowth has commenced the wall of the respiratory cavity rises up around its base, in the form of a fold, which later on embraces, with the placenta, the whole of the embryo.

The author points out that these results do not agree with those of Todaro,* whose observations he discusses in some detail.

The processes just described may be regarded as those of the first developmental period, and we now come to a description of the external form of the embryo in its different stages. The body is at first pyramidal in form, it then increases in length and breadth more than in height, and so becomes flattened out; a little later the placenta becomes gradually separated from the embryo, until at last they are only connected together by a short round stalk, which itself finally disappears. Hand in hand with these changes the rudiments of the organs begin to be laid down; the heart appears very early, and the pericardiac cavity is at first very large. The boundaries of the respiratory cavity are, at first, very difficult to make out, as it is filled with and lies in a mass of follicular cells. The internal cell-mass is gradually absorbed, when the outer contours of the cavity become, of course, better marked. Simultaneously with the appearance of the egestive orifice we get the first signs of the musculature of the body. This arises in the form of eight muscular bands which commence at the upper end of the body and extend to about its middle. Somewhat later we see the commencement of the ventral folds, which gradually pass into the lower wall of the respiratory cavity. The enteric canal is one of the last organs to appear, and the nerve-ganglion can only be made out with difficulty before it has assumed the form of a vesicle and lost its relations to the outer cell-layers. The elæoblast is not developed early but grows rapidly so soon as it has begun to put in an appearance. The history of these organs is carefully discussed, and several points of disagreement with the accounts given by Todaro appear in its course.

In the latest periods of development we find a thickening of the follicular wall, and the definite formation of the organs. In conse-

* See this Journal, iii. (1883) p. 41.

quence of this thickening the secondary follicular cavity is completely filled by cells, and forms a mass between and from which the muscles and the blood are derived; it may, therefore, be looked upon as analogous to the mesoderm, from which it is to be distinguished by the fact that it takes no part in the formation of the heart. The embryo, at this period, increases in length and approaches its definite form.

The preceding observations deal with what has been seen in *Salpa pinnata*, and in concluding his account of the latest development of the organs, Salensky directs attention to the history of its nervous system, which is important for the early connection which obtains between the rudimentary nervous system and the enteric tract.

The history of *Salpa africana* is not so fully dealt with as that of *S. pinnata*, but an opportunity is taken to refer to the services rendered by Barrois, and to point out the differences in the two sets of observations. The important, or apparently important, distinction between *S. africana* and *S. pinnata* lies in the presence of a body-cavity in the former; this would seem to depend on the greater poverty of cells in part of the mesoderm, and in the absence of that proliferation of the cells of the wall of the follicle to which attention has already been directed in speaking of *S. pinnata*. In other words, the embryos of *S. pinnata* are provided with a body-cavity, but it is very early filled up with cells. The paper concludes with a few words on the characters of the placenta, and speaks in terms of approbation of Barrois' work on this subject.

Anatomy and Histology of Brachiopoda Testicardinia.*—J. F. van Bemmelen, after an exhaustive survey of the work of preceding students of this group, deals in detail with the various organs.

Treating of the shell, he finds that the perforations in it do not alter with age, and, since new canaliculi are not formed, it follows that the shell of the Brachiopoda does not grow by intussusception, but only at the margin. The so-called shell-papillæ have often been compared with the vascular outgrowths in the cellulose-mantle of the Tunicata, but as the spaces in the former do not communicate with the vessels in the mantle, it is obvious that no close comparison is possible between the two sets of organs. The shell of the Brachiopoda is only a cuticular structure, comparable to that of Annelids and Arthropods, and is not of the same nature as that of the Mollusca, which arises from a shell-gland.

The proper body-wall is to be distinguished from the mantle; the ectoderm forms a single layer of epithelial cells which have large nuclei, but are themselves relatively small. The layer of connective tissue consists of a true supporting substance lying between the ectoderm and the parietal mesoderm; varying in thickness, according to its relations to different organs, it has always a homogeneous structure with interspersed connective-tissue cells. Distinct bands of tissue are to be made out in some genera, but they all seem to be nothing more than differentiations of the homogeneous supporting

* Jen. Zeitschr. f. Naturwiss., ix. (1882) pp. 88–161 (5 pls.).

substance; and this remark applies even to the "stalk." The complicated lacunar system, described by Hancock, would appear to be merely due to the mode of connection of the stellate connective-tissue cells; and this is the more probable as an explanation, since Hancock, in his very careful account, never mentions the connective-tissue elements. To the author just mentioned we owe our first exact knowledge of the nervous system of this group. On either side, the wall of the pharynx gives rise to a fold which carries the œsophageal ring; below the pharynx is the ventral ganglion, in which we find two continuous lateral aggregations of ganglionic cells, connected with one another by nerve-fibres. From this there is given off, on either side, a thick nerve which at once divides into two branches; one of these, the thicker, passes to the dorsal half of the mantle, the other (and thinner) to the commissure. The lateral commissures curve over in front of the pharynx, towards the body-wall, and thence pass into a nerve-cord, which extends into the walls of the arms and expands, above the mouth, into a ganglion. It follows, therefore, that there are supra-œsophageal arm-nerves, and these are much larger than the sub-œsophageal. After describing the minute structure of the parts of the nervous system, the author passes to the genital organs.

Here, again, we find the remarkable researches of Hancock duly noted; but the more modern author has been able to make out that there is no sharp distinction between the epithelium of the body-cavity and the ovarian cells; and that, therefore, the ova of the Brachiopoda may be said to be metamorphosed cœlomic cells. It is true also of the spermatozoa that they arise from a germinal epithelium which is directly continuous with the epithelium of the body-cavity. This cœlom is lined by a single layer of flattened epithelial cells, and the genital glands are placed in folds of the supporting substance, in which cavities are developed. It seems certain that the Brachiopoda Testicardinia have the sexes separate.

The muscles consist of parallel simple fibres of contractile substance, which for the most part are not connected together, and which apparently extend through the length of the whole muscle. Nuclei are to be found on their outer side, and these are surrounded by a very small amount of granular protoplasm. The only difference between the plain and striated muscles is to be seen in the structure of the latter.

Coming to the discussion of the systematic position of these difficult forms, the author finds that, in the histological structure of their body-wall, musculature, and genital organs, they present all the characters of the Enterocœlia of the Hertwigs; the mesenchymatous layer is but feebly developed.

Instead of being allied to the Mollusca, they appear to present the closest resemblance to the Chætognatha. Not only do the ectoderm, the enteric canal, and the body-cavity present just the same developmental history, but in both we observe a feeble development of connective tissue; the only differentiation in this layer is the formation of supporting fibres. Further, we find that epithelia are always simple, and the generative products are directly produced from one of them

A similar kind of agreement is to be seen in the minute structure of the nervous system; in both the ganglia are made up of simple small nerve-cells and nerve-fibres; the latter alone form the peripheral tracts, and these are simple flat bands. The resemblance in the mode of forming plexuses is no less striking. The nervous plexus under the ectodermal epithelium of the arms of the Brachiopoda is to be compared to the stellate ganglionic cells connected with the neighbouring nerve-trunks which are to be found under the epidermis of the Chætognatha. As is well known, both the groups under discussion exhibit the formation of an enterocœle; both present a very symmetrical structure, and have a spacious cœlom. The segmentation into three metameres in the Brachiopoda is, in the adult, exhibited by the gastroparietal and ileoparietal bands; in both groups the second and third metameres stand in relation to the reproductive organs. The vasa deferentia of the Chætognath belong as much to the type of segmental organs as the infundibular ducts of the Brachiopod. In both groups we find the enteric canal supported by dorsal and ventral mesenteries; in both, the central organ of the nervous system consists of an œsophageal ring with an upper and a lower pair of ganglia. From the latter arise two large nerve-trunks which pass backwards and branch largely, without, however, giving any signs of a ladder-shaped nerve-cord. The upper ganglion of the Brachiopod innervates the arms and that of the Chætognath the short tentacles. Though there is a difference in the characters of the sensory organs, there are indications of a degeneration of these parts in the Brachiopod.

The important differences are the possession by the Brachiopod of a shell and of a stalk; but the former has been shown to be merely a thickening of the cuticle, and the secondary value of the latter is spoken to by the differences between the Testi- and Ecardines.

Arthropoda.

a. Insecta.

Early Developmental Stages of Ovum in Insecta.*—Dealing first with the Hymenoptera, A. Weissmann finds that in *Rhodites rosæ* the shell of the mature egg is provided with a long peduncle; the germinal vesicle is replaced by a transparent nucleus, the first segmentation-nucleus, devoid of a membrane. The yolk contracts, and the nucleus becomes a whitish streak, which divides into two halves; these shorten, constituting the "polar nuclei" of the author; they perform amœboid movements; the posterior nucleus gives rise, by elongation and fission, to about thirty nuclei. The nuclei now migrate to the periphery and become surrounded by the yolk, which forms a superficial layer to the ovum, and soon assumes a cellular character, forming the blastoderm, the cells of which are uniform in character, and all have a large nucleus directly invested by deutoplasm-granules; the periphery of the cell is formed of clear protoplasm. The anterior polar nucleus buries itself in the yolk at the period at

* Beiträge z. Anat. u. Physiol. als Festgabe Jacob Henle, Bonn, 1882. Cf. Rev. Sci. Nat., ii. (1882) pp. 135-9.

which the nuclei derived from its fellow migrate to the circumference; it then divides in the same manner as the posterior nucleus, producing a long line of nuclei, which are directly invested with protoplasm, and constitute the vitelline cells. The blastoderm of the ventral aspect thickens, forming the ventral plate, while it becomes attenuated dorsally; the amnion makes its appearance as a single fold or prolongation of the dorsal part of the head end, consisting of a single layer of cells extending round to the ventral side. Shortly after the amnion is formed, the germinal plate becomes grooved by a transverse linear furrow, which, after deepening, remains stationary for a time, and then disappears; it is considered by Weissmann as a gastric invagination homologous with the longitudinal groove found in other insects. The mouth and cephalic constriction then appear, and a little later the proctodæum. At first sight the mesoderm seems derived wholly from the so-called vitelline cells; but in reality it is derived from certain globose cells from the middle of these, behind the transverse groove and near the anterodorsal aspect, which become detached, and range themselves below the blastoderm as a definite layer.

The mesenteron is bounded by large granular endodermic cells which inclose the remains of the yolk.

At the moment of hatching the larva has thirteen segments; it cannot be determined whether the anterior division corresponds to a single segment, or to the whole head, as in all insects but the *Muscidæ*. Three pairs of tubercles, placed behind the mouth, are the rudiments of the mouth-organs: the first pair form the mandibles; the second, which become rudimentary, represent the maxillary palps; the third pair fuse into a median plate, which protects the mandibles. The antennæ appear as tubercles on the procephalic lobes, and remain in this condition during larval life. No trace of limbs occurs on the segments of the body at any stage.

Biorhiza aptera differs from *Rhodites* in developing a vitelline membrane; as in *Rhodites*, the yolk penetrates into the peduncle of the egg, but it is retracted again. The first segmentation-nucleus lies in a transparent mass of protoplasm situated at the anterior pole; after performing amœboid movements, it elongates in a transverse or oblique direction, and divides into the two polar nuclei, and almost immediately after this the posterior of the two itself begins to divide, while the anterior remains for a time inactive, and then divides; the two sets of nuclei derived thus are indistinguishable. It appears that when about 100 nuclei have been thus formed they become the centres of cells, part of which move to the surface and form the blastoderm.

The anterior cells of this membrane emit slender anastomosing pseudopodia like those of Radiolaria, which project into the space beneath the vitelline membrane, but disappear after a short time. The amnion is formed as in *Rhodites;* no gastric invagination has been observed; the development of the segmental appendages corresponds with that of *Rhodites*, and here also there are no thoracic appendages; the small anterior segment of the larva represents the entire head.

Diptera.—In *Chironomus* sp. the freshly laid ova show a considerable contraction of the yolk to have taken place; a superficial layer of protoplasm is also distinctly differentiated. Before the formation of any traces of a blastoderm, masses of protoplasm, with or without nuclei, become detached (usually at the anterior pole), and subdivide, thus forming polar globules. Later are formed the polar cells, a mass of twelve cells, at the posterior pole. The plasmatic cortex is now occupied by nuclei, and takes on a cellular character, forming the blastoderm; after this an anterior nucleus buries itself in the vitellus, and there divides, as in *Rhodites*.

Orthoptera.—In *Gryllotalpa* the ova are large, and there is no plasmatic cortex. Cells composed of clear protoplasm are found in the yolk soon after fertilization; they make their way to the surface and there divide, forming islands of smaller cells; these islands become connected together, and eventually form a continuous blastoderm.

Three types of blastoderm formation are distinguished in the above insects.

1. *Gryllotalpa.*—Ova large; cells appear in yolk and pass to the surface.

2. *Rhodites, Biorhiza.*—Free nuclei pass to the surface and there collect around them cell-bodies rich in nutritive yolk.

3. *Chironomus.*—The nuclei pass to the surface, to find there a layer of protoplasm already differentiated.

4. The *Poduridæ* present a fourth case. The small ovum forms a blastodermic sac by total segmentation.

It is noteworthy that the nuclei form no karyokinetic figures in the process of division; their amœboid movements have a purely nutritive object; the nuclei are not necessarily centres of attraction for protoplasm, for they remain for a considerable period independent of any cellular bodies.

Innervation of the Respiratory Mechanism in Insects.*—Dr. O. Langendorff denies Dönhoff's statement that respiratory movements in insects cease after decapitation. Experiments on humble-bees, wasps, cockchafers, and dragon-flies, show that these movements continue in the abdomen after removal of the head, and even of the thorax. Indeed, in some cases, sections of the abdomen of a dragon-fly, as small as one ring and a half, continued the rhythmical respiration. It is therefore evident that the nerve-centre for respiration is not in the head. A decapitated cockchafer breathed for an hour. Heat was found to increase the activity of respiration in mutilated as in healthy individuals. Graphic illustrations are given of normal respiration, and compared with those obtained from decapitated specimens.

Histology of Insect Wing-muscles.†—G. V. Ciaccio finds that in most insects the wing-muscles may be decomposed into fibrillæ (in others, into striated fibres: *Sphinx*, *Libellula*, &c.). In the former

* Arch. Anat. u. Phys., 1883, p. 80. See Science, i. (1883) pp. 316-7.

† Arch. Ital. Biol., ii. (1882) p. 131.

case the fibrillæ are united into bundles of various sizes by a cementing substance, in which the nuclei lie either both in the interior and upon the surface of the bundle (*Hydrophilus*, *Dytiscus*), or upon the surface only (flies). The bundles are held together by tracheæ, and sometimes also by fat-cells. In the cement, further, are always found distinct particles (Aubert's *masse grumeleuse interfibrillaire*), which do not occur in the other muscles. The fibres are composed of fibrillæ, and have nuclei either upon the surface (*Cicada*) or in the middle (*Libellula*). In some insects the fibrillæ are arranged as in a folded lamella, the leaves of the folds running out from the centre of the fibre towards the surface, seen in cross-sections. The nerve-fibres terminate in motor plates (probably several for each fibre), consisting of a granular basal substance, in which are imbedded the ramifications of the axis-cylinder. The wing-muscles are more readily dissociated into fibrillæ than those of the rest of the body, from which they are further differentiated by the absence of a true sarcolemma.

Flight of Insects.*—M. Amans thinks that in the theories of artificial wings, propounded by Marey and Pettigrew, both observers have failed to see that the base of the wing is formed of two planes set at an obtuse angle in such a way that, when the wing is descending, the posterior plane presents its concavity to the column of air struck. The author has made some anatomical observations on *Æschna*, *Siren*, and *Locusta*, which seem to confirm his view.

Locomotion of Insects on Vertical Glass Surfaces.†—H. Dewitz supports the explanation already advanced by Blackwall of this phenomenon, viz. that a glutinous liquid is exuded from the apices of hairs which surround the lobes of the feet. He resorts to direct observation of the living insect, fixing it feet uppermost to a glass slide which is placed under the Microscope. By this means the ends of the hairs surrounding the lobes of the feet are seen to emit a transparent substance by which the foot adheres to the glass; if the foot is then drawn away, drops are seen to be left on the glass, corresponding in position to the hairs of the foot-lobes. In cases where there are no hairs, as in the bugs, the adhesive material proceeds directly from pores in the foot. Many larvæ (e. g. *Muscidæ*, the alder-leaf beetle, and the saltatory Dipterous larvæ) use a similar substance in their movements, probably also half the total sum of perfect insects, including most Diptera and Hemiptera, many Hymenoptera and Coleoptera, and probably those Orthoptera which neither leap nor fly.

The same author ‡ has examined the structure of the foot of a beetle, *Telephorus dispar*, and other insects with the same object. The hairs on the foot run out to sharp points, below which are placed the openings of the canals. The glands are chiefly flask-shaped unicellular organs, lying in the hypodermis of the chitinous coat; each opens into one of the hairs; they are each invested by a structureless tunica propria, and they contain granular protoplasm, a nucleus placed at

* Comptes Rendus, xcvi. (1883) p. 1072.
† SB. Ges. Naturforsch. Freunde (Berlin), 1882, pp. 5–7.
‡ Tom. cit., pp. 109–13.

the inner side, and a vesicle, prolonged into a tube which, traversing the neck of the gland, is attached to the root of the hair; the vesicle receives the secretion. Each gland is connected with a fine nerve-twig. Secretion is probably voluntary.

In *Telephorus* this power is soon weakened and not rapidly renewed. Among the adhesion-hairs are distributed others, supplied by nervous twigs; a ganglionic swelling is placed just below the end of each of these.

On the hairless globular tarsi of many Orthoptera almost all the cells of the hypodermis of the sole form unicellular glands; each sends out a long fine chitinous tubule, which is connected with its fellows by very fine hairs and is continuous with the chitinous coat of the foot and opens through it. The sole of the foot is elastic and adapts itself to minute inequalities of surfaces; the interior of each tarsal joint is almost entirely occupied by an enlargement of the trachea, which acts on the elastic sole like an air-chamber, rendering it tense and at the same time pliant. The apparatus found on the front legs of the male of *Stenobothrus sibiricus* must have the function of causing the legs to adhere closely to the female by the excretion of an adhesive material; gland-cells and enlarged tracheæ are found here also. The hairs of the anterior tarsi of male *Carabi* appear also to possess the adhesive function. The adhesion of pollen to bees appears to be similarly effected. The excretion is effected from the glands in *Telephorus* by contraction of the protoplasm, which when the parts are teased in indifferent solutions exhibits active movements; the secretion has been seen to be driven from the internal vesicle into its neck; many facts as to vital contraction are given in support of this view of the cause of the exudation of the glutinous matter.

Salivary and Olfactory Organs of Bees.*—P. Schiemenz in this elaborate paper commences with the ordinary bibliographical *résumé;* he describes in detail the structure of the parts of the digestive tract which bears on the question of the salivary glands, and discusses their developmental history and their function. He points out that all glands have to supply a secretion, and that the more the separate cells take a larger share in this, the richer the secretion from a smaller number of secreting cells. In bees there are two essentially different modes by which this is effected, and the two types may be appropriately spoken of as the *intracellular*, and the *intercellular*. In the simplest case of the latter we find a sac lined by a simple layer of cells, so arranged that each cell presents a proportionately broad surface to the common cavity; the material is obtained from the blood at the opposite ends of the cells. If the sac elongates, its diameter diminishes and we get the tubular form. In these two "systems" the cells are widest in a direction parallel to the lumen of the sac or tube. If the cells become spheroidal, there is a proportionate diminution in the secreting surface, and efferent canals appear between the cells. As a matter of fact, glands of this kind of construction do, among the Apidæ, stand remarkably close to the saccular or the tubular.

* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 71–135 (3 pls.).

The intracellular type obtains in what the author calls his first, fourth, and fifth systems; here the cells are attached to long stalks and float in the cœlom; and thus it happens that the whole of their surface is able to take up the necessary matter from the blood. In connection with the consequent large secretion, secretory canaliculi are developed, which make their way into the cells, surround the plasma, and so afford a correspondingly large surface for excretion. To this type a much greater secretory activity must be ascribed than to that in which secretion is intercellular. In the so-called fourth system we find that the intercellular spaces are very rare, and in the first (*Bombus*) the free cells are arranged in acini. Both these arrangements must be due to the large number of cells present.

The author concludes that the so-called crop has, in honey-bees, the function of, at times, completely shutting off the honey-stomach from the chyle-intestine, while the small intestine forms the means of communication between the latter and the rectum. The salivary glands vary considerably both in genera and species, and it seems probable that their functions are also very varied. While one system of glands is formed within the *propria* of the first portion of the larval spinning-glands, two others are derived from its efferent canals, and the other two are fresh structures formed by an invagination of the epidermis. The olfactory mucous gland of Wolff is salivary in function.

Mimicry of Humming-birds by Moths.*—The striking resemblance in size, form, and movements, of the South-American *Macroglossa Titan* to humming-birds, which has been noticed by Bates, Fritz Müller, and others, and referred to the similarity in their habits, is believed by Dr. Krause to be a case of protective mimicry, the moths benefiting by their resemblance to the birds, which have few winged enemies. The closeness of the resemblance is supposed also to protect the moths from the humming-birds, which always give chase when they recognize them. To do away with an objection that might be urged from the similar appearance of European *Macroglossæ*, which have no Trochilidæ to imitate, it is assumed either that these birds occurred in Europe in late tertiary times, or that the moths are recent importations from the new world.

β. Myriopoda.

Systematic Position of the Archipolypoda.†—Dr. A. S. Packard, jun., has some observations on the recent paper by S. H. Scudder on the Archipolypoda, a group of fossil Myriopoda, from the Carboniferous formation. These forms had a fusiform body largest near the middle of the anterior half or third; the head appendages were carried on a single segment. Connected with each of the ventral plates of the other segments are a pair of long jointed legs, with large spiracles outside them; the mouth is set transversely. Dr. Packard has lately been studying the Lysiopetalidæ, "a rather aberrant and synthetic family of Chilognatha," and he points out that Scudder must have had,

* Kosmos, Nov. 1882. Cf. Science, i. (1883) p. 203.
† Amer. Natural., xvii. (1883) pp. 326–9.

in his comparisons, the Julidæ in view, as some other Chilognaths have a fusiform body. He doubts the accuracy of the statement that the head appendages are carried on a single segment. The legs are a little longer than in the Lysiopetalidæ, and several of the characters indicated are to be found in them also. Owing to the possession of spinulate spines the fossils have a somewhat remarkable appearance, but an approach to them is probably to be found in the barbed setæ on the segments of the embryo *Strongylosoma*, and in *Polyxenus fasciatus*. Dr. Packard thinks that the fossils form a group nearly equivalent to the Lysiopetalidæ, but below them. They are truly of an ancient type, as is shown by the retention and enlargement of the spiny setæ which occur in embryonic and larval Chilognaths, and by the presence of a pair of spiracles on each segment (and not on alternate ones, as in Chilognaths and Chilopods). The characters of their appendages are in keeping with this view. The legs would appear to have had sharp claws, and there is no evidence to justify us in thinking that they were swimming organs.

The peculiar organs regarded by Scudder as supports for branchiæ are, in Packard's opinion, suggestive of this idea, and "it is to be hoped that fossils will be discovered, with remains of the branchiæ themselves; though it is hard to see how they could have been associated with such large spiracles." Dr. Packard would divide the order of Chilognatha into two sub-orders, one of the Archipolypoda and the other of Chilognatha vera. In the latter the possession by each segment of two pairs of legs is a secondary and acquired character. A parallel may be found in the Phyllopod Crustacea, where "from two to six pairs of legs in post-larval life arise from a single segment."

Anatomy and Development of Peripatus Capensis.* — Prof. F. M. Balfour's memoir on this species (a preliminary note of the embryological portion having already appeared †) is now published, edited by Prof. H. N. Moseley and Mr. A. Sedgwick, and illustrated by eight beautifully executed plates.

The more important facts of the early development of *Peripatus Capensis* are as follows:—1. The greater part of the mesoblast is developed from the walls of the archenteron. 2. The embryonic mouth and anus are derived from the respective ends of the original blastopore, the middle part of the blastopore closing up. 3. The embryonic mouth almost certainly becomes the adult mouth, i.e. the aperture leading from the buccal cavity into the pharynx, the two being in the same position. The embryonic anus is in front of the position of the adult anus, but in all probability shifts back and persists as the adult anus. 4. The anterior pair of mesoblastic somites gives rise to the swellings of the pre-oral lobes and to the mesoblast of the head.

It is intended that the present memoir should be followed by others, comprising a complete account of all the species of the genus *Peripatus*.

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 213–59 (8 pls.).

† See this Journal, *ante*, p. 52.

New Species of Polydesmus with Eyes.*—The species of *Polydesmus*, a genus embracing some of the most common Myriopods, are, as a rule, eyeless. Dr. A. S. Packard, jun., has, however, found at Portland, in Oregon, a form in which eyes are present. The characters in general are such as not, perhaps, to warrant a separation from the genus, and he proposes to name it *P. ocellatus*. It might be easily mistaken for a *Trichopetalus*. The individuals were mature, or nearly so, as they were horn-brown. The 12–13 ocelli were conspicuous and black. In the cylindrical body and thick antennæ it approaches *P. cavicola* Pack., from a cave on the shores of the Great Salt Lake. It differs from that species, which is eyeless, in the fusiform body, much thicker antennæ, and the finer granulations as well as the larger number of segments.

δ. Crustacea.

Caprellidæ.†—P. Mayer commences with an account of the systematic characters of these Crustacea, reviewing the work of his predecessors, and showing how these have advanced the study of the group. An account of the families, genera, and species then follows, more especial attention being, of course, given to the forms found in the Bay of Naples. This section concludes with an alphabetical list of the genera and species. An account of the little that is known as to the geographical distribution then follows; and this is succeeded by a series of chapters on the anatomical and histological characters.

The difficult question of the relation of the Caprellidæ to the Cyamidæ is in conclusion discussed, though we have no palæontological and but little embryological evidence to assist us. Some answer, however, must be given to the question: Are the Cyamidæ really allied to the Caprellidæ, and is the group of the Læmodipoda a natural one? We find that the external and internal organization of a Cyamid is similar to that of a Caprellid; in both the abdomen has undergone a like kind of degeneration, and there is much in common in the characters of the liver, the external generative organs, and the general segmentation of the body. The group, then, of the Læmodipoda being a natural one, we have to see whether the ancestor of the group stood closer to the Caprellidæ or the Cyamidæ. The result of the inquiry is in favour of the former, and leads to the view that the latter were derived from a form not unlike *Caprella*. The genus *Platycyamus* appears to be a very lately developed Cyamid. The Læmodipod ancestor seems to stand in closest alliance to the Gammaridæ amongst the Amphipoda, but the cause of the peculiarities in its organization cannot be certainly defined; there is not as yet sufficient evidence to justify us in ascribing it to their more sessile mode of life.

Coloration of Idotea tricuspidata.‡—C. Matzdorff divides his essay into three portions; in the first or descriptive part he gives an account of the coloration of these Isopods, which he arranges in five

* Amer. Natural., xvii. (1883) pp. 428–9 (6 figs.).

† Fauna u. Flora des Golfes Neapel, vi. 4to, Leipzig, 1882. 201 pp. (10 pls. and 39 zincographs).

‡ Jen. Zeitschr. f. Naturwiss., ix. (1882) pp. 1–58 (2 pls.).

groups; in the first all the examples have the same colour, whatever that may be; in the second we have those with bright lateral bands, and a broad dark median band; in the third there are bright lateral bands, but there is a delicate white median one, and between it and each edge there is a broader dark longitudinal band; in the fourth group the examples are spotted, and in the fifth there is a kind of transverse striation. In some rare cases individuals were observed which could not be brought into any one of the above categories. The separate groups are fully described.

In the second or anatomical portion an attempt is made to bring these colours into relation with histological characters; it has been found that all green or greenish colours are not due to the animal itself, but to lower algæ; similarly diatoms influence the coloration in the direction of yellowish-brown, but other animals, such as the Infusoria under the carapace, do not appear to affect the appearance of the animal. The reddish or greenish-grey colours seen along the median line are due, not to the tissues of the animal, but to the vegetable remains in their intestine. The unpigmented or non-coloured spots are referable to the histological elements; if pale yellow or reddish they have been affected by the chitin; oil-drops in the hypodermis give rise to a yellow coloration. White, red, and brown bands are to be referred to the chromatophores in the hypodermis; these consist of an upper layer of chitinogenous cells and of a lower layer formed of a granular protoplasmic mass with nuclei regularly distributed, but without cell-walls. The chromatophores, which are regularly arranged, have a diameter of from 60 to 80 μ. They clearly belong to the series of amœboid cells, and though two kinds of them can be distinguished they are histologically equivalent to one another.

In the third, or physiological, section the author discusses the influence of the constituents of the environment; he finds that food has no influence on the coloration, while temperature is frequently seen to be of importance. Light, of course, is still more a factor, while the proportion of salines in the water often greatly affects the form, size, and coloration. As to the coloration itself, we may see that there is no proof of any warning or protective aim, nor does sexual selection seem to have been of any influence. All the colours and markings of *Idotea* must be regarded as being sympathetic and referable to adaptations to environment. The colours are found to change rapidly, stages from bright yellowish-brown to dark brown succeeding one another in one and the same animal; or there may be a direct passage from a light to a dark shade; brightly coloured specimens, placed in dark vessels, gradually dilate their chromatophores, while dark examples placed in white porcelain vessels contract their colouring cells.

The white chromatophores change less rapidly, and moreover function in an opposite sense to the dark ones, for they dilate when the animals become lighter, and contract as they become darker. The change in colour appears to be associated with the presence and functional activity of the optic organs.

The author discusses the advantages and characteristics of the different kinds of coloration, and concludes by suggesting that the phylogenetic development of the separate varieties is to be explained by supposing that the unicolor examples are the oldest. When the dark contents of the intestine became apparent, "white chromatophores" must have been developed. Bands would appear in relation to a habitation among marine grasses, and doubly-banded forms would imitate the marking of the *Zostera*-leaves. A further change of environment would add to the advantage of the possession of spots in the markings.

Vermes.

Annelids of the Canary Islands.*—P. Langerhans has some observations on the anatomy of Syllideæ, where he has found in all species of the genera examined a canal in the strong œsophageal teeth; in *Syllis aurantiaca* he has been able to make out the poison-gland, which is a paired tube lying dorsal of the œsophagus. He has studied the process of reproduction by fission, and has addressed himself to the question as to whether the same individual once or repeatedly produces, asexually, sexual forms. The result is in favour of the latter, or Krohn's view; the time between the productions varied from 25 to 49 days, but he never observed the production of more than two sexual forms. Each bud, as it broke away, carried with it a number of the parent-segments; nearly all the segments of the new person contain generative products. There does not seem to be any difference between males and females, but three forms of head are to be distinguished. Of the 57 species noticed 9 at most are new.

Anatomy and Histology of Terebellides Stroemii.†—J. Steen, in describing the cephalic region of this annelid, says that it is extremely interesting to observe under the Microscope the working of the delicate tentacles; they are pushed out in all directions, and may become extended so much as to be longer than the body. They carefully test all the bodies they desire before they seize them. They are provided with a delicate cuticle, below which is an hypodermis, consisting of elongated cylindrical cells. Below these there is a thin transversely striated membrane, comparable to the supporting lamella of hydroid polyps. Below this, again, are the longitudinal muscles, separated by interspaces of various sizes. The spaces thus included are filled by a plexus of connective tissue, and the separate fibres are thickened at various points, and are provided with distinct nuclei. The transverse dissepiments, seen by M'Intosh in the tentacles of *Magelona*, could not here be detected. After some account of the thoracic and abdominal regions, and a description of the characters which distinguish *Terebellides* from *Terebella*, the author passes to his histological observations.

The dermo-muscular tube consists of the ordinary four layers;

* Nova Acta Acad. Caes. Leop.-Carol., xlii. (1881) pp. 95–124 (2 pls.).

† Jen. Zeitschr. f. Naturwiss., ix. (1882) pp. 201–46 (3 pls.).

no pores could be detected in the hyaline cuticle, nor were the rod-shaped or spindle-like structures which are so often to be made out in the hypodermis of Annelids detected in this form. In correspondence, possibly, with their tubicolar habit, the muscular layers are not thick; the division of the body-cavity into three longitudinal chambers, owing to the development of muscular plates, such as has been signalized by Claparède in various *Terebellæ*, could not be here demonstrated.

The cœlom is well developed, especially in the more anterior regions, but the so-called dissepiments marking off the separate segments were not observed. The body-cavity is continued not only into the parapodia, but also into the lobes of the head, the gills, and the filiform tentacles; with the exception of the first, the outgrowths are traversed by a connective-tissue plexus. A large lacuna at the base of the tentacles supplies those organs with fluid, and they then become extended. The general cavity is filled with a colourless fluid, which exhibits a constant lively movement, not marked by any regularity in direction. A number of discoid elliptical corpuscles, which are never coloured, are always to be found in it. The liver is made up of lamellæ, which are set longitudinally, and it has the same cylindrical epithelial cells as the œsophagus; the muscular stomach is regarded as being homologous with the similarly named organ in *Lumbricus;* sections made across the anterior portion of the intestine (or "hindgut") exhibit the presence of a number of inwardly projecting folds, the largest of which is to be seen on the dorsal side; these folds are richly provided with blood-vessels, and when the dorsal vessel becomes smaller and divides into two, as it does in the 22nd segment, the folds become proportionately smaller. The author takes the same view as Claparède with regard to the tubicolar functions of the salivary glands.

The "ventral medulla" is intermediate in character between the step-ladder form, seen in Serpulidæ and others, and the fused cord found in *Scoloplos*, for here the two longitudinal cords are only separated by a connective-tissue sheath; in the hinder portion of the body it passes into the hypodermic area. Special ganglionic enlargements are not developed in each body-segment. Unlike what obtains in the earthworm, but just as in the oligochætous Enchytræids, the investing membrane consists of a homogeneous, and not striated, neurilemma, but there does not appear to be any cellular structure in this neurilemma.

The most conspicuous portions of the blood-vascular system are the two large dorsal and ventral vessels, and, in addition to these two, there are two longitudinal vessels on either side of the body; of these the upper is more delicate than the lower. The blood is corpusculated; the corpuscles being numerous, and of an elliptical form.

The females appear to be more numerous than the males, and are distinguished by their yellowish-green colour; the ova are developed in a tissue of the segments, which seems to be homologous to the ovaries described by Grube in the Terebellidæ. The germinal

vesicle is of some size. The spermatozoa, like the ova, are developed in large masses, and, like them, pass into the spaces in the thoracic parapodia. They are generally found aggregated, and separate spermatozoa are but rarely detected; they resemble in form those of *Magelona*. The segmental organs are confined to the 5th and 6th segments, and serve as efferent ducts for the genital products; they consist of an infundibular and a spherical portion, and the cilia are confined to the former. The latter apparently serves as the secreting organ of the matter by means of which the genital products become attached. The external pore resembles that seen by Cosmovici in *Pectinaria*.

Exogone gemmifera.*—C. Viguier, after a brief account of the work of Pagenstecher and others on this annelid, states that he has frequently found both males and females in the sexual condition; some of these have, and some have not setæ, so that the view of Pagenstecher that the asetal forms are agamic, and the setose sexual is not confirmed; so, again, *E. martinsi* may or may not have long setæ.

The author enters into some detail with regard to the history of this development, as this form has served as the basis of Pagenstecher's doctrine of lateral buds; such an exception to the general rule that germination takes place in a longitudinal direction deserved reconsideration; and the author proposes to deal fully with the matter in a more extended memoir.

Structure and Development of Phoronis.†—W. H. Caldwell, in a preliminary note on this Gephyrean, points out that the epistome lying in the short line between the mouth and anus is the persistent pre-oral lobe of the larva, and that this line is the median dorsal line. The ventral surface is produced into a foot, which constitutes the main part of the animal. The central nervous system retains its primitive epidermic condition, and concentrations take place round the mouth to form a post-oral nerve-ring; in front of this are situated a pair of sense-organs, which may be spoken of as the "ciliated pits"; the protuberances in *Rhabdopleura*, figured by Sars, may be their homologues. The body-cavity is divided by mesenteries into three chambers, and there is, further, a septum which passes from the line of the nerve-ring into the œsophagus. The genital pores of Kowalevsky are the external openings of a pair of nephridia, each of which consists of a simple ciliated tube, the cell-walls of which are filled with brown concretions. These tubes open into the posterior chamber of the body-cavity. There is a closed system of blood-vessels, containing nucleated red corpuscles, and the walls of all the vessels are contractile. The sexes are united in the same individual, and the generative products are formed from cells of the efferent blood-vessel which runs in the left anterior chamber of the body-cavity, and the generative cells, like the nerve-cord, are asymmetrically placed.

* Comptes Rendus, xcvi. (1883) pp. 729–31.
† Proc. Roy. Soc., xxxiv. (1883) pp. 371–83.

In the history of development we see that segmentation is unequal, and that the gastrula is invaginate; the mesoblast is formed bilaterally from the endoderm on either side of the blastopore; from the time when two or three mesoblast-cells are budded off on either side a cavity is present in each mass so formed; these cavities are the two halves of the body-cavity, and the author regards the mode of origin as a modification by simplification of the enterocœl type, as seen in *Argiope*. The mesoblastic diverticulum into the pre-oral lobe grows rapidly, and distinct somatic and splanchnic layers soon become apparent; the muscle-cells in this region have all the histological character of the mesenchyme of the Hertwigs. The endoderm becomes thickened in the pre-oral lobe to form the future nerve-ganglion, and as a post-oral ring indicating the position of the line of future tentacles in the circumœsophageal nerve-ring of the adult. The anus is, from the first, terminal in position, and the four divisions of the alimentary canal early become apparent; the cells of the first stomach, though ciliated, are much more amœboid than in the adult, and throughout larval life digestion goes on in this region. The whole mesoblast arises as two endodermic sacs, the walls of which form somatic and splanchnic layers.

The vessels were seen to arise as splits in the splanchnopleure.

The author is of opinion that the life-history of *Phoronis* offers a solution of many morphological problems; the pre-oral ring, corresponding to the velum of a Trochosphere, is from the earliest stages reduced relatively to the post-oral; the latter persists throughout life as a circumœsophageal ring; the ganglion of the pre-oral lobe disappears with the change from a free to a fixed mode of life. The whole body-cavity is an enterocœl; the intracellular portion of the excretory system atrophies when the vascular system is developed. The identity of the *Phoronis*-larva, up to the formation of the nephridia and before the outgrowth of the anal region, with the Trochosphere-type of Hatschek is complete; the distinction drawn by the brothers Hertwig between the histological characters of the mesenchyme and mesoderm utterly breaks down in *Phoronis*, and it may be suggested that the other Trochospheres are enterocœles. The author discusses briefly the relations of *Phoronis* to the Brachiopoda and Polyzoa, and suggests that the larvæ of these forms are modified from the Trochosphere by the earlier attainment of the relation of the ventral surface which in *Phoronis* is only accomplished during the metamorphosis.

Development of Borlasia vivipara.*—W. Salensky finds that, though the males are much smaller than the females, the generative organs are in both sexes formed on the same type, being constituted by paired sacs which open to the exterior by pores at the sides of the body. These sacs are lined by a secretory epithelium, the ovum is fertilized *in situ*, and there remains till the larva is developed. Segmentation is complete and unequal, and before the blastula is con-

* Bull. Sci. Dép. Nord, v. (1882) pp. 462–9.

verted (by invagination) into the gastrula, a certain number of mesodermic cells put in their appearance. The position of the blastopore is with difficulty distinguishable, and its ultimate fate is unknown. The anterior end is early distinguished by a small ectodermal thickening, which is the rudiment of the future cerebral ganglion. This thickening soon separates from the ectoderm and takes on the form of a transversely widened plate, soon to be distinguished into two halves.

At the inferior pole a mass of cells begin to give rise to a pyriform organ, which is, physiologically, an excretory organ, and morphologically interesting from its relations to the proboscis and its resemblance to a similarly placed organ in the larvæ of Annelids. The mesoderm forms at first a simple layer, but soon gives rise to a muscular and a splanchnopleuric layer, but at the anterior end of the body no cœlom is developed, and here the mesoderm forms the connective tissue which surrounds the different organs of the head.

Before the cleavage of the mesoderm a saccular cavity is formed around the proboscis, which grows very rapidly and extends to the hinder end of the body. This is the sheath of the proboscis, and it is absolutely independent of the cœlom. Its first rudiment has the form of a thick layer of cells surrounding the rudiment of the proboscis; it then divides into two layers, which are only single, for the future, at the lower end. The three blood-trunks arise before the formation of the body-cavity, and a rhythmical contraction is apparent very early.

In the intestine the digestive cells appear to multiply during the whole of the life of the *Borlasia*, and to lead to a complete disappearance of the lumen of this canal. The lateral nerves appear from comparative data to be the homologues of the ventral chain of Annelids, but embryological facts offer certain difficulties to this interpretation; the rudiments of the lateral nerves are always distinctly separated from the ectoderm, and seem to be direct prolongations of the cephalic plate; the author is inclined, therefore, to believe that the lateral nerves of Nemertines are the homologues not of the ventral chain, but of the peripharyngeal commissure of Annelids; in connection with this, we would quote the late Prof. Balfour: "A circumoral nerve-ring, if longitudinally extended, might give rise to a pair of nerve-cords united in front and behind, exactly such a nervous system, in fact, as is present in many Nemertines."*

New Human Cestode—Ligula Mansoni.†—Dr. T. S. Cobbold describes a Cestode, twelve of which were found in a Chinese, lying in the subperitoneal fascia, about the iliac fossæ, and behind the kidneys, a single one being found lying free in the right pleural cavity. They were from 12 in. to 14 in. long, 1-8th in. broad and 1-64th in. thick. The Cestode comes nearer to *Ligula simplicissima*, frequently found in

* Comp. Embryol., ii. p. 312.

† Journ. Linn. Soc. (Zool.) xvii. (1883) pp. 78–83 (4 figs.).

the abdominal cavity of fresh-water fishes, than to any other species, and without asserting positively that it may not be a variety of that form, the author thinks, from the unique character of its habitat associated with certain differences of form, that it may properly be regarded as the immature representative of a totally distinct species.

Echinodermata.

Psolus and its Allies.*—Prof. F. Jeffrey Bell, after giving the reasons which justify the use of the name *Psolus* as against *Cuvieria*, and a list of the known species and well-established synonyms, proceeds to give some account of some of the forms of that genus of Holothurians. He finds that in *Psolus fabricii* the younger are more strongly imbricated than older specimens, and that the species has a circumpolar distribution, being found in the Japanese seas. A new subgenus—*Hypopsolus*—is formed for a specimen remarkable for having a comparatively small number of covering plates which are invested in a thick integument in which there are some calcareous deposits. *Psolus* (*Hypopsolus*) *ambulator* is found in the Australian seas. He finds that the Polian vesicle is not, as might have been supposed, better developed in the more heavily than in the less heavily armed species, and he concludes that, for the purposes of systematic zoology, it is most convenient to recognize three sub-genera—*Psolus* S. Str. (*Eupsolus*) with granular plates, a median row of trivial suckers, and no basal web to the tentacles; *Lophothuria* with large granulated plates, no median row, and a basal web; while *Hypopsolus* has a very rich supply of trivial suckers and the scales invested in a thick integument.

Perivisceral Fluid of the Sea-Urchin.†—Prof. E. A. Schäfer finds that if the perivisceral fluid of an *Echinus*, which has about the same specific gravity and chemical composition as sea-water, be drawn from the "shell" it rapidly undergoes what appears to be a sort of coagulation; this coagulation now shrinks until it is reduced to a small shred of coloured substance, and in this respect it closely resembles that of vertebrate blood. Examined with the Microscope, the clot is found to contain all the corpuscles, and these are so closely arranged and their processes are frequently so long and ramified, that it is difficult to make out the material in which they are imbedded. This material has been overlooked by Geddes, but by experiment it is possible to see that there is a clear substance in which the corpuscles are imbedded; this coagulable material does not appear to be fibrine, but to be a body more nearly allied to mucin, "although the possession by it of the remarkable property of spontaneously shrinking after its first formation gives it a deceptive similarity to fibrine." The author promises a more detailed account of his investigation.

* Proc. Zool. Soc., 1882, pp. 641–50 (1 pl.).
† Proc. Roy. Soc., xxxiv. (1883) pp. 370–1.

Eudiocrinus.*—Professor E. Perrier signalizes the presence of Mr. Herbert Carpenter's new genus *Eudiocrinus* (so called from its known four species having been found in the Pacific Ocean) in the Atlantic; and he proposes to call the new form (discovered by the 'Travailleur') *E. atlanticus*. The five arms, which alone are possessed by this genus, are here greatly elongated, and only diminish slowly in diameter. It is distinguished by the number and size of the saccular organs; it would not seem to be able to attach itself by its cirri, as do most of its allies, but to lie with arms and cirri extended on the slime of the ocean, where it fears neither waves nor currents. *Eudiocrinus* is not a primitive, but a modified Comatulid, and the author takes again the opportunity of pointing out that the simplest forms of all types appear to be capable of forming colonies by gemmation; and that the abyssal fauna is, in great part, made up of forms descended from littoral and shallow regions. The conditions of existence becoming more and more constant, or even altogether uniform, species from very different stations have, when a certain zone is passed, been able to distribute themselves largely, and so to give to the deep-sea fauna a monotony remarkable as compared with what obtains in the neighbourhood of the shore.

Arctic and Antarctic Crinoids.†—Prof. F. Jeffrey Bell describes a specimen of *Antedon* from the Straits of Magellan which he is unable to distinguish as more than a variety from the very well known Arctic form *A. eschrichti*. After pointing out such differences as there are, he confesses his inability to believe that the Magellan variety and the northern form could ever have had an ancestor of the species *A. eschrichti*. He concludes that a case of this kind forces on the mind the difference between the objective and the subjective view of what constitutes a species, or in other words, the differences between a Linnean and a genetic conception of specific relationship. He "would not like to be thought to have failed to recognize that in the discrimination of the homogenetic and the homoplastic factors of species, we have at present no criterion other than what even a friendly critic might call our ignorance. Chorology and palæontology will have to do for species what comparison and embryology are doing for organs."

Classification of the Comatulæ.‡—P. Herbert Carpenter here discusses and criticizes parts of Prof. Jeffrey Bell's 'Attempt to apply a Method of Formulation to the Species of the Comatulidæ.'§ After allowing the necessity of some method of formulation, he discusses especially the formulæ given for those species which he has himself described. Confusion has arisen from preceding writers, himself included, having not sufficiently recognized the different

* Comptes Rendus, xcvi. (1883) pp. 725–8.
† Proc. Zool. Soc., 1882, pp. 650–2.
‡ Ibid., pp. 731–4.
§ See this Journal, ii. (1882) p. 791.

morphological values of a syzygy in the proximal and in the distal portions respectively of the rays and their subdivisions. A fresh mode of formulation is given which it is hoped will be found more elastic, and is based upon seven important generalizations, which are formally stated. He indicates the presence of ten arms only by the number 10; assumes that, unless otherwise stated, the first syzygy on the arm is on the third brachial; if it is on the second, 2 *b* is placed in the formula: 2 *d* or 2 *p* indicates that there are two distichals or two palmars, of which the axillary is a syzygy, and $\frac{d}{2}$ or $\frac{p}{2}$ that the two distichals or palmars are united by a syzygy. Like Bell, he uses *R* to denote the syzygial union of the two outer radials, and he accepts the proposal for the cirri.

Cœlenterata.

Origin of the Spermatozoa in Medusæ.*—In a short paper on this subject C. Merejkowsky calls attention to the interesting fact that the mature reproduction-follicle of *Cassiopea* or *Rhizostoma* bears a close resemblance to the same organ of *Pelagia* during its very young stages. At a very early stage of development the immature follicles are almost exactly alike in all three genera, but in *Cassiopea* they undergo very little change. The mature organ is a simple ovoidal pouch, lined with endoderm-cells, and filled with spermatozoa. According to the brothers Hertwig, *Pelagia* passes through a similar stage long before maturity is reached; but its development in this genus does not stop here, and it finally becomes a long, irregular pouch, the tortuous ramifications of which are interlaced in an inextricable tangle.

It is easy to discern that the simple pouches of *Cassiopea* open, when mature, into the genital sinus, into which Merejkowsky has seen the ripe spermatozoa escape. He believes that similar openings probably exist in *Pelagia;* and he thinks the failure of the Hertwigs to find them is due to the great complexity of the mature follicle in this genus, rather than to the absence of openings.

The paper also contains a minute illustrated account of the transformation of the endoderm-cells which line the follicle into spermatozoa.

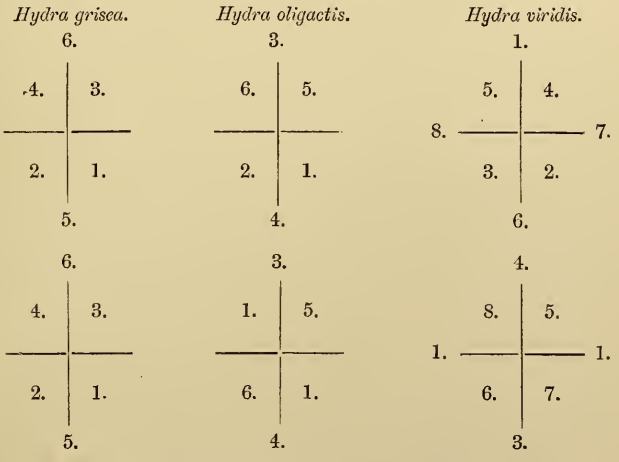
Endodermal Nervous System in Hydroids.†—Dr. Lendenfeld states that he independently discovered in Australian species of *Eudendrium* and *Campanularia* the ring of glandular cells which has been recently described by Weissmann and Jickeli in *Eudendrium*. He also finds in all the Campanularidæ which he has examined a well-developed nerve-ring of endodermal origin, running around the proboscis, just inside the oral opening. In this region a number of sensory cells are found, with stiff hairs, which project among the cilia

* Arch. Zool. Expér. et Gén., x. (1882) pp. 577–82 (1 pl.). Cf. Science, i. (1883) pp. 287–8.

† Zool. Anzeig., vi. (1883) pp. 69–71.

of the endoderm-cells. The study of sections shows that these sensory cells are connected with the ganglion-cells, and the processes which are given off from these ganglion-cells anastomose with each other in such a way as to form a complete nerve-ring around the mouth. This ring he regards as the central nervous system of Hydroids, and he calls attention to the fact that it not only originates from the endoderm, but is without a homologue in the Medusæ, since none of the Medusæ are known to have a nerve-ring in this position.

Development of the Tentacles of Hydra.*—The great variability of fresh-water hydræ demands that the order of development of the tentacles should be tabulated in a great number of specimens, in order to discover the law of their appearance. Jung has thus studied nearly 250 specimens of three species; and he concludes that, while there is no fixed order, each species does have a typical or average mode of development, which is more or less closely followed by the majority. The law varies with the species, and the results of Jung's researches are shown in the following diagrams :—



The vertical line is that axis of the bud which passes through the axis of the parent. The upper series of diagrams shows the typical order of appearance in normal buds of the three species named. This order was followed in 46 per cent. of 156 specimens of *H. grisea*, in 83 per cent. of seven specimens of *H. oligactis*, and in 55 per cent. of 21 specimens of *H. viridis*. The second line shows the order of re-appearance in specimens after cutting off the oral end of the body with the tentacles. It was followed in 69 per cent. of 48 specimens of *H. grisea*, in 3 specimens of *H. oligactis*, and in 47 per cent. of 12 specimens of *H. viridis*.

* Morph. Jahrb., viii. (1882) pp. 339–50. Cf. Science, i. (1883) p. 81.

Porifera.

Vosmaer's Porifera.—The second part of this work on sponges, with plates V. and VI., has appeared; the whole of the text is devoted to the history of the investigation of this subject, and is not yet completed. Plate V. is filled with figures borrowed from Zittel, and some of that palæontologist's figures, with others from Haeckel, and two new ones are to be found on plate VI.

Fresh-water Sponges of Russia.*—The 12 nominal European species of the Spongillidæ are considered by Dr. W. Dybowski to be reducible, by exclusion of synonyms, to five, viz. *S. lacustris* auctt., *fluviatilis* auctt., *vespa* Martens, *erinaceus* Lieberkühn, *muelleri* Lieberkühn. Of these species *S. lacustris* is the only one recognized by Dr. Dybowski from the Russian Empire; it appears to extend to near Lake Baikal and to Kamtschatka, although some hook-like appendages upon gemmules of specimens from the latter country throw some doubt on their identity. Besides this is described a new species, *Spongilla sibirica*, from Lake Pachabicha (near Lake Baikal) and a lake in the Caucasus, distinguished from other species by the proportions of the spicules and structure of its gemmulæ; also three species of *Meyenia*, to which, in consideration of his want of information as to the characters of previously described species, the author with praiseworthy prudence refrains from assigning specific names; of these *Meyeniæ*, No. 1, from Livonia and Southern Russia, is distinguished by the often, and deeply, cleft margin of the amphidisk-spicules; No. 2, from Esthonia, Poland, and the Dnieper, has similar amphidisks, but has the skeleton-spicules shorter; in No. 3, from Kamtschatka and Minsk, in Western Russia, the ends of the amphidisks are deeply cleft into a few large teeth and some or all of the skeleton-spicules are spined; the specimens from the two localities differ in small points from each other.

In the last species Dr. Dybowski finds the same phenomenon as Mr. J. G. Waller (in 1878) did in *S. fluviatilis*, viz. the occurrence of both spined and smooth skeleton spicules in the same specimen. As in the genus *Lubomirskia* in 1880,† so in *Spongilla* and *Meyenia* now, the author finds a considerable range of variation in the sizes of the spicules, e. g. the skeleton-spicules of *S. lacustris* may range from ·114 mm. to ·25 mm. in length, and from ·002 to ·01 mm. in thickness in different specimens, those from salt water (Gulf of Finland) all bearing smaller spicules than the other specimens; the gemmule-spicules of fresh-water examples range from ·024 to ·05 mm. in length, and from ·02 to ·04 mm. in thickness. Of *Spongilla sibirica*, the only specimens of which spicule-measurements are given exhibit a comparatively low range of variation, but here, as in the other species described, the range of variation appears to be intimately connected with the number of localities from which specimens were examined, and in none of the species does the variation of the skeleton-

* Mém. Acad. Sci. St. Petersburg, xxx. (1882) No. 10, 23 pp. (3 pls.).
† See this Journal, i. (1881) pp. 257–8.

spicules reach so high a pitch as in *S. lacustris*, although in *Meyenia* No. 2, the length of the amphidisks and the diameter of their end-disks both vary from ·006 to ·014 mm. The diameter of the gemmules of *S. lacustris* ranged in the Russian specimens from ·28 to ·4 mm. The gemmule of *S. sibirica* is remarkable for its two layers, the inner firm, structureless, yellow, the outer thin, colourless, transparent, and made up of non-nucleate, polygonal cells.

A useful list of 84 papers dealing with this group is appended.

Protozoa.

Bütschli's Protozoa.—Parts 17–19, with plates XXIX. to XXXVIII. of this work have appeared. The text deals with the Sporozoa. The Gregarinida are divided into the two orders of the Monocystidea and of the Polycistidea, each with 13 genera. The three genera of the latter order lately described by Schneider are subsequently noticed. The wide distribution among the Invertebrata of these parasites is noted, and their common occurrence among mammals is pointed out. The next chapter deals with the Myxosporidia or so-called fish-psorosperms, and the spore-formation is carefully described. The lately suggested name of Sarcosporideia (Balbiani) is applied to the "tubes" (sarcocysts) of Miescher and Rainey, the correct relations of which to the Gregarinida must still remain an open question. The figures illustrating the Radiolaria are completed, and those of the Sporozoa commenced.

Flagellate Infusorian, an Ectoparasite of Fishes.*—L. F. Henneguy describes an ectoparasite of young trout, which seems to cover their surface. When fixed these infusoriform parasites have the appearance of small pyriform cells, fixed by their narrower end. A clear line divides the body into longitudinal asymmetrical halves, and this line corresponds to a groove in which is placed a long flagellum. When the animal is free it expands and has the form of a *Haliotis*-shell. If the fish dies the infusorian guest abandons it and disappears, probably to take up its abode on another. In ordinary infusions the parasite cannot live, for fresh water appears to be a necessity of its existence.

Most nearly allied to *Bodo* (*Amphimonas*) *caudatus*, it is distinguished by having three, instead of two, flagella; the new form may be called *B. necator*. This, which appears to be the first described ectoparasitic flagellate infusorian, seems to cause the death of its host by giving rise to an alteration in the activity of the cells of the epithelium; for in a young trout the cells appear to be undergoing active division, which ceases when it becomes attacked by this parasite.

Gigantic Actinosphærium Eichhornii.†—Professor J. Leidy noticed in an aquarium what appeared to be eggs adherent to the edges of the leaves of *Vallisneria*. On examining the egg-like bodies

* Comptes Rendus, xcvi. (1883) pp. 658–60.
† Proc. Acad. Nat. Sci. Philad., 1882, p. 260.

with a lens, they were observed to be covered with delicate rays. On transferring some of the bodies to the field of the Microscope, they proved to be giant specimens of the larger sun-animalcule, *Actinosphærium Eichhornii*. They measured from three-fourths to one millimetre in diameter, independent of the rays, which extended from one-fourth to half a millimetre more. One of the smaller individuals contained four water-fleas (*Daphnia*), a third of a millimetre long; and one of the larger contained six of these. The *Actinosphærium* appears to be tenacious of life, several specimens having been retained alive and in good condition for three days in a drop of water in an animalcule cage. They had discharged the *Daphnia*, but retained their original size. One of oval form measured 1 mm. long by 0·75 mm. broad. The smaller ones measured 0·75 mm. in diameter. After another day they appeared in good condition; but the rays were contracted so as to be about half the original length, and many had a minute granular ball at the end, apparently effete matter thrown off from them. At this time the animalcules were returned to the aquarium.

Dimorphism of Foraminifera.* — MM. Meunier-Chalmas and Schlumberger, attracted by the discovery by one of them of the presence of two forms in every species of Nummulite, have lately directed their attention to the Miliolidæ, where they have observed similar phenomena; so that dimorphism is to be detected in both the great divisions of the Foraminifera-Perforata and Imperforata. The dimorphism of the Foraminifera is characterized by a difference in the size and arrangement of the primary chambers; the smallest and those of a median size have a central chamber, which is relatively very large (Form A), while in larger forms this cavity is only visible when highly magnified (Form B). In a given species no external character, save that of size, would give the least suspicion of this difference.

The authors proceed to give some details of the distinctive characters of the two forms, and promise in a further communication to discuss the hypotheses by which this remarkable difference may be explained.

Vampyrella Helioproteus, a New Moneron.†—T. W. Engelmann describes this new organism, which he found among *Confervæ* in the neighbourhood of Utrecht. It is distinguished from all previously known forms by the "heliozoa-form" (globular, with long pseudopodia), being able to pass over into the round flat discoid amœba-form. This metamorphosis was observed in three instances, and extended over about five minutes. In the heliozoa-form the organism moves by means of its long contractile pseudopodia, like an *Actinosphærium;* in the amœba-form it creeps without pseudopodia or change of form. It bears a very close resemblance to *Hyalodiscus rubicundus* (Hertw. and Less.), differing only in the absence of a nucleus and of

* Comptes Rendus, xcvi. (1883) pp. 862–6.

† K. Akad. van Wetensch. Amsterdam, Nov. 25, 1882. See Bot. Centralbl., xiii. (1883) p. 214.

contractile vacuoles. The author adduces, from the discovery of this organism, a fresh argument against drawing any sharp line between the different sections of the Protista.

Hæmatozoa of Fishes.*—P. Mitrophanow gives some account of new monadiform parasites in the blood of fishes, and discusses their relations to the blood-corpuscles. He points out that, in consequence of their having been looked upon as "curiosities," the literature that deals with the presence of foreign organisms in the blood of healthy animals is in a very fragmentary condition. The author has discovered in the blood of *Cobitis fossilis* and of *Carassius vulgaris* an organism which, at first sight, appeared to be a Nematode, but which exhibited, on closer examination, no internal differentiation, and some amœboid characters. Of about 30–40 μ long, it was only 1–1½ μ broad, and moved with great rapidity; at its anterior end there was a flagellum of considerable length, and the anterior was narrower than the hinder end. When dying, or less active, the organism became much shorter, and an undulating membrane became apparent. The body of the organism, the membrane, and the flagellum, all exhibited a homogeneous highly refractive protoplasm of great contractile power. Some striking varieties of this form are described. The hæmatozoon found in *Carassius vulgaris* was at first sight similar to that found in *C. fossilis*, and just described, but it differed from it in its somewhat larger size, and in the more distinct appearance of its undulating membrane. For the reception of these forms a new genus must be established which may be known as *Hæmatomonas*, and the two species as *H. cobitis* and *H. carassii*. After giving an exact definition of these forms, the author proceeds to refer to the views of Gaule, and states that he comes to the conclusion that he has here to do with organisms, and not with the derivates of anatomical elements, and he agrees with Prof. Ray Lankester that we have here Cytozoa. In consequence of the paper of the last-mentioned naturalist,† he feels it would be superfluous to discuss in detail his objections to Gaule's views.

BOTANY.

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

Nature of the Process of Fertilization.‡—E. Strasburger gives a *résumé* of the various modes in which the sexual elements, whether "planogametes" or "aplanogametes," unite in various classes of algæ. He repeats his previously expressed view that impregnation consists essentially in the union of the morphologically equivalent parts of the two cells that unite. This union is, however, confined to the cell-protoplasm and cell-nucleus, and does not extend to the chro-

* Biol. Centralbl., iii. (1883) pp. 35–44.
† See this Journal, ii. (1882) p. 519.
‡ Niederrhein. Ges. f. Natur- u. Heilkunde, Bonn, Dec. 4, 1882.

matophore. The fact that the reduction in size of the spermatozoid is accompanied by a loss of protoplasm, and that the nuclear substance predominates in the mass of the spermatozoid, has led to the conclusion that what takes place in impregnation is chiefly a transport of nuclear substance, while the cell-protoplasm in the zygote or impregnated oosphere plays the part of a storage of force. Impregnation is therefore essentially a union of cell-nuclei, although any union of cell-nuclei is not necessarily an act of impregnation. The coalescence of the plasmodia of Myxomycetes he does not regard as an act of impregnation.

The ordinary mode for the protoplasm of the male element to reach that of the female element is by permeation through pores already in existence, though in certain instances it would seem as if it made use of pores specially prepared for the occasion.

Pollination of Araceæ.*—G. Arcangeli has observed the mode of pollination of several species of Araceæ, especially *Arum italicum*, *Dracunculus crinitus*, *vulgaris* and *canariensis*, and *Sauromatium guttatum*. In all of these a very great rise of temperature is observable within the spathe for a very short time at the moment of flowering, accompanied by a powerful odour. The object of these is to attract insects to assist in the fertilization. These are detained by the parastemona as in a cage from the time when the stigmas are mature until the dehiscence of the anthers; *A. italicum* at least being distinctly proterogynous. The author does not consider there is sufficient evidence to warrant the theory of the carnivorous habits of these plants, there being a complete absence of any digestive fluid and of any special digestive glands in the spathe.

Pollen-tubes.†—J. Kruttschnitt disputes the ordinary view that the ovule is fertilized by the entrance of the pollen-tube into the embryo-sac. He has never been able to detect that such an entry actually takes place. He believes, on the contrary, that the pollen-tube discharges the fovilla or contents of the pollen-grain into the conducting tissue of the style, whence it is conducted by the funicle to the papillæ which surround the micropyle, and then absorbed by endosmose. In the case of *Cereus grandiflorus* he states that the ovary contains on an average about 3000 ovules, and that it is impossible, on the ordinary theory, that all these ovules could become fertilized, for there is not nearly space, either in the conducting tissue of the style or in the ovarian cavity, for this number of pollen-tubes.

Autoxidation in Living Vegetable Cells.‡—Traube has given the name of *autoxydable Körper* or, as we must clumsily translate the new term, autoxidizable substances, to those bodies which, at a low temperature, and by the action of free passive oxygen, can be oxidized, forming, in the presence of water, peroxide of hydrogen. Starting

* Nuov. Giorn. Bot. Ital., xv. (1883) pp. 72–97.
† Amer. Mon. Micr. Journ., iii. (1882).
‡ Bot. Ztg., xli. (1883) pp 65–76, 89–103. Cf. Science, i. (1883) pp. 229–30.

from Traube's statement of the changes which accompany oxidation, especially the formation of peroxide of hydrogen, J. Reinke gives the following as a sufficient basis on which to build a theory of oxidation in living cells. (He has himself shown that there exists in certain plants, notably in the beet, a very easily oxidizable body, which he has named rhodogen. This substance is one of Traube's autoxidizable bodies, and is only one of many which may be reasonably assumed to be present in cells.)

1. In every active cell, autoxidators are formed; that is, substances which, at a low temperature and with absorption of molecular oxygen, can be oxidized by the decomposition of water.

2. By oxidation of these substances, peroxide of hydrogen is produced.

3. This peroxide of hydrogen can, under the influence of diastase, and probably of other ferments, cause oxidations as energetic as atomic oxygen can.

Lastly, the seat of this activity is the periphery of the protoplasmic body of the cell; and this body possesses an alkaline reaction.

Structure of the Bundle-sheath.*—The cells of the typical bundle-sheath are, according to S. Schwendener, parenchymatous and of variable length; the pores, when present, are mostly round, though occasionally oval and oblique. Like the mestome-bundles, the sheaths form a continuous system. The impermeability of the walls of the sheaths is no invariable characteristic, since portions only of them are often cuticularized. It is, however, the rule for the bundle-sheaths to be, when mature, less permeable than ordinary cellular tissue, this being due to a relatively impermeable lamella, which bounds the inner surface of their tangential walls; in consequence of this the sheaths often assume the functions of the epidermis. The formation of pores on the inside of the sheaths stands in close relationship to the mode in which their permeability decreases in the course of their development. When the inner wall has become so thick as to be impermeable there are no pores.

In many monocotyledons, dicotyledons, and ferns, the cells of the bundle-sheath of the root are of two kinds; opposite the primordial vessels are "transmission-spots" more permeable than the rest of the sheath, from the cells having thinner walls. The vessels are water-conducting tubes, and these transmission-spots serve to keep up a connection between this system and the fresh bark; they are the sluices of a system of irrigation. In the mestome-sheath of monocotyledons these passages are found at two symmetrical points, while in ferns they always correspond, in number and position, to the groups of primordial bundles. These passages appear never to occur in the bundle-sheaths of rhizomes.

Besides the suberization of the radial and transverse walls of the bundle-sheaths, the tangential walls remaining unchanged, Schwen-

* Abhandl. K. Akad. Wiss. Berlin, 1882 (5 pls.). See Bot. Centralbl., xiii. (1883) p. 77.

dener distinguishes several modes of mechanical thickening, viz. of the cell-walls of the sheath itself; of the walls of the neighbouring cortical cells, as is usually the case in ferns; of both these; of the cells of the sheath, and of the layers of cells which bound it on the inside, &c.

The bundle-sheaths are formed, in the most various ways, from a true cambium as well as from a meristem; and the thickenings are also either of parenchymatous or of cambial origin.

Buried Leaf-buds.*—F. Hildebrand describes several cases of adventitious leaf-buds which have become completely covered over by the surrounding tissue, and concealed by the bark, breaking out, however and developing in the following season. They occur in *Actinidia polygama*, *Rhus glabra*, *Ptelea trifoliata*, *Virgilia lutea*, *Calycanthus floridus*, and *Philadelphus inodorus*.

Structure of the Wood of Conifers.†—E. Russow publishes a very detailed account of the structure of the wood, especially of *Picea excelsa* and *Larix sibirica*, with especial reference to the development of the pits and of the membrane of the wood-cells. The general conclusions arrived at are as follows:—

The vessels and tracheides act as pumps, which, either by suction or pressure, force the water in the wood from the root to the leaves. The suction is first caused by transpiration, by means of the bilateral pits in the wood; the positive pressure by the osmotic force of the contents of the paratracheal cells of the medullary rays, and parenchyma of the wood by means of the unilateral pits. The latter manifests itself especially at the time when negative pressure prevails in the vessels or tracheides, in order to bring about filtration of difficultly diffusible substances in the cells of the medullary rays and of the wood-parenchyma.

Medullary Rays of Conifers and Dicotyledons.‡—P. Schulz describes the pores in 48 species of conifers occurring in the contiguous walls of the tracheides and in the cells of the medullary rays, by which these elements communicate with one another. Those in the medullary rays are always unbordered, while those in the tracheides are sometimes bordered, sometimes not. In some species of *Pinus* the tracheides which border the medullary rays have I-shaped thickenings, the medullary rays having at the same time large oval pores. They protect the tracheides from the pressure exercised by the turgidity of the medullary cells. The medullary tracheides occur only in the Abietineæ, and are of two forms. In *Pinus* these cells are thickened in a jagged way, and are arranged in several rows; in *Cedrus*, *Larix*, and many species of *Abies*, they are narrowed, have not these jagged thickenings, and are usually arranged in one or two rows in each medullary ray. The bordered-pit-cells are dead and

* Bot. Centralbl., xiii. (1883) pp. 207–12.

† Ibid., pp. 29–40, 60–8, 95–109, 166–73 (5 pls.).

‡ Schulz, P., 'Das Markstrahlengewebe u. seine Beziehung zu den leitenden Elementen des Holzes,' 23 pp. (1 pl.) Berlin, 1882.

have no power of turgidity, performing the function of receptacles for water.

In dicotyledons the medullary rays are also connected with the vessels by pores, which sometimes attain a very great size. The woody parenchyma and medullary rays stand in a close relationship with the vessels, and together furnish a channel for the transport of solutions of organic compounds; the sap is conducted through the former, while the vessels serve as reservoirs to which the former give up their superfluous sap, and take it up again from them when wanted.

Diagnostic Value of the Number and Height of the Medullary Rays in Conifers.*—B. Essner points out that these characters cannot be used for the determination of the species of fossil coniferous woods, as has been proposed, since both the number and height of the medullary rays are subject to considerable variation in the same species according to age; they are most numerous in the first annual ring, then decrease, and subsequently again increase. Their height increases regularly with their age.

Achenial Hairs and Fibres of Compositæ.†—G. Macloskie describes the peculiar hairs attached to the achenes of many Compositæ. Duplex hairs are characteristic of the families Asteroideæ, Eupatorieæ, Vernonieæ, Helianthoideæ, Helenioideæ, Arctotideæ, and Mutisieæ; but do not occur in Anthemideæ or Cichorieæ. Each hair consists of two tubes with a partition between, like the two flues of a double chimney; they contain special fibres or elaters which are rapidly uncovered on access of moisture, swelling and escaping by the tips of the tubes, as by the lifting of a pair of trap-doors. There are also similar fibres contained in superficial cells of the pericarp in Cichorieæ, which aid in the dehiscence of the seed-vessel (generally described as indehiscent), and the pressing out of the seed.

Crystals of Calcium oxalate in the Cell-wall.‡—Crystals of calcium oxalate in the cell-wall have hitherto been observed in *Mesembryanthemum*, *Sempervivum*, *Dracœna*, *Araucaria*, *Welwitschia*, and *Ephedra*. H. Molisch records an additional instance in *Nuphar* and *Nymphœa*. They occur especially in the walls of the well-known stellate hairs of the fundamental parenchyma which surrounds the intercellular spaces of the leaf and leaf-stalk. The crystals vary greatly in size from all but invisible points to $6 \cdot 6\ \mu$ in length.

Influence of Sunny and Shaded Localities on the Development of Leaves.§—Haberlandt, in an examination of the comparative anatomy of the assimilating tissues in plants, came to the conclusion that light is almost without influence in governing the shape of leaves or the arrangement of the chlorophyll-cells. On the other

* Abhandl. Naturf. Ges. Halle, xvi. (1882). See Bot. Centralbl, xii. (1882) p. 407.

† Amer. Natural., xvii. (1883) pp. 31–6.

‡ Oesterr. Bot. Zeitschr., xxxii. (1882) pp. 382–5.

§ Jen. Zeitschr. f. Naturwiss., ix. (1882) pp. 162–200 (1 pl.). See Amer. Journ. Sci., xxv. (1883) pp. 313–4. Cf. this Journal, ii. (1882) pp. 368, 373; *ante* p. 92.

hand, Pick has shown that the shape and arrangement of assimilating tissues are certainly controlled to some extent by the presence of full sunlight or of shade. Both of the foregoing works were preceded by a paper by E. Stahl in which the influence of the intensity of light on the structure and arrangement of chlorophyll-parenchyma was pointed out. It may be further stated that the same author had previously studied the effect of the direction and intensity of light on some movements in plants. In a paper just published E. Stahl incorporates some of the earlier results obtained by him, and adds several facts of considerable interest. The thesis may be stated as follows: The elongated or palisade cells are best adapted for light of high intensity; the looser parenchyma for that of low intensity. (To this in passing may be added Areschoug's observation that the looser or spongy parenchyma is that best adapted for transpiration, and characterizes the foliage of moist climates; where either local or climatic relations render too rapid transpiration undesirable, these layers are protected by a palisade system.) The author has devoted most attention to plants which can endure shade as well as bright sunlight, and here wide differences are alleged to exist between the forms growing in light and those found in shade. All the differences are of the character above described, namely adaptation to sunlight by the development of a better palisade system. The critical point of the investigation is plainly that leaves developing in sunlight have a less strongly characterized spongy parenchyma, and a better marked palisade system. In view of the fact that these two systems are generally found as stated in the thesis, the author asks whether this ought not to influence our treatment with plants in greenhouses.

Position of Leaves in respect to Light.*—E. Mer states that certain parts of the leaf, usually the limb, receive luminous impressions, while other parts, as the petiole, the motile organs, &c., execute movements for the purpose of placing the former in a favourable position for receiving light. The mechanism of these movements consists in an augmentation of growth, or only of turgidity, resulting in curvatures and torsions. The presence of light seems indispensable to these movements.

Photepinasty of Leaves.†—W. Detmer proposes the term "photepinasty" for the epinastic position of leaves induced by light. The normal unfolding of leaves is due to paratonic nutation. Light first induces stronger growth in the upper side of the leaf; and it is to this phenomenon that he proposes to apply the term.

Movements of Leaves and Fruits.‡—The movements of leaf- and flower-stalks in virtue of which they assume an inclined or horizontal position are attributed by H. Vöchting to various causes, geotropism, heliotropism, and the weight of the flowers or fruit. In addition to

* Comptes Rendus, xcvi. (1883) pp. 1156–9. See also this Journal, *ante*, pp. 235, 237.

† Bot. Ztg., xl. (1882) pp. 787–94.

‡ Vöchting, H., 'Die Bewegungen der Blüten u. Früchte,' 199 pp. (2 pls.) Bonn, 1882. See Bot. Ztg., xli. (1883) p. 13.

these external, there are also internal causes, which he classes under two heads:—"rectipetal," those which tend to straighten the organ in question; and "curvipetal," those which tend to cause it to curve.

Distribution of Water in the Heliotropic Parts of Plants.*—A. Thate derives the following conclusions from experiments on *Coleus*, *Clematis*, *Phaseolus*, *Dahlia*, *Sambucus*, and *Silphium*:—

1. In the parts of plants with positively heliotropic curvature, no difference can be detected between the amount of water in the illuminated and the shaded side.

2. It cannot, however, be positively asserted that no such difference exists.

3. Very nearly exact determinations of the amount of water in the parts of plants which curve heliotropically can be obtained by Kraus's method.

Excretion of Water from Leaves.†—G. Volkens describes the structure of the portion of the tip of the leaf of *Calla* adapted for the excretion of water. In addition to the ordinary stomata, the epidermis of the cylindrical apex of the leaf is provided with very large modified stomata, which he terms water-fissures. The internal tissue is composed of assimilating parenchyma surrounding the extremities of the spiral bundles, which are in close contact with a tissue composed of thin-walled cells with watery contents which the author terms "epithem." The cells of the epithem form a spongy tissue, the large and numerous intercellular spaces of which are always filled with water. The closed ends of the spiral vessels are inserted between the cells of the epithem. The excretion of water in the fluid state on the surface of the leaves is due chiefly to root-pressure.

The Aroideæ is the only order of monocotyledons that possess a true secretory apparatus. In other orders the epidermis gives way at the apex of the leaf, and the vessels discharge their superfluous water into the fissure. Where a special excreting organ is present, it usually occupies the apex and teeth of the leaf; but sometimes, as in *Crassula* and *Urtica*, is dispersed over the surface of the leaf.

Movements of Water in Plants.‡—J. Vesque has devised a simple method of demonstrating the transfer of water in the stems of plants, which promises to have a wide application. The stem is cut obliquely during immersion in water, and the thin part of the severed stem is placed in the field of the Microscope, of course completely wet on the cut surface. After the cover-glass is adjusted and the stem securely fastened, so that it cannot be easily disturbed by subsequent treatment, a very little freshly precipitated calcium oxalate, or other finely divided substance, is introduced under the cover. If the leaves have not been removed from the stem, a rapid current is at once observed

* Pringsheim's Jahrb. f. Wiss. Bot., xiii. (1882) pp. 718–29.

† Volkens, G., 'Ueber Wasserausscheidung in liquider Form an den Blättern höherer Pflanzen,' 46 pp. (3 pls.) Berlin, 1882. See Bot. Centralbl. xii. (1882) p. 393.

‡ Ann. Sci. Nat. (Bot.) xv. (1882) pp. 5–15. See G. L. G. in Amer. Journ. of Sci., xxv. (1883) pp. 237–8.

to flow towards the cut surface. The insoluble salt collects at the open mouths of the vessels, often passing into the capillary tubes after a temporary arrest, and the same phenomenon is repeated several times as the minute plugs are formed and then sucked in.

With low powers of the Microscope it is possible to use a second slip instead of the thin cover, and then the simple apparatus can be held more firmly in its place. In any case it is possible to measure the rapidity of the current by means of a micrometric eye-piece; and several such measurements are given.

When the stem is quickly stripped of its leaves, the current is stopped at once. But when, on the other hand, a leaf or a part of the stem is pinched, there is immediately a backward flow of water.

It is well known that two conflicting views have been held by physiologists as to the channel by which the upward movement of water in wood takes place. Some think that the transfer is solely by imbibition, and that no free water is carried from cavity to cavity of the wood-element, or rather, that no free water exists in the cavities. Others have held that free water is carried from one wood-element to another, and that the walls themselves play only a subordinate role. To these opposed views may be added a third, which appears to be a compromise; namely, that water in a free state actually exists as a thin lining on the cell-wall. The chief advocate of the latter view has, however, abandoned it in favour of the imbibition theory. A recent publication by Elfving* details the results of experiments which considerably strengthen the "cavity" theory. Now just at this point come observations of Vesque, in a continuation of the paper regarding the method of direct demonstration, which go far towards showing that here, as was long ago suspected, the truth is to be found between the extremes. These experiments, which need to be carefully repeated, indicate that under certain circumstances the transfer of water takes place by means of the cavities themselves, but that in all cases they may serve the part of reservoirs.

Moreover, the calibre and length of the vessels regulate the rate of transpiration; resistance to the movement of the water following the law of Poiseuille, so that the resistance is inversely proportional to the fourth power of the diameter, and directly proportional to their length. We give in full the close of Vesque's paper.

"It is evident that p having reached its maximum, that is to say the suction resulting from transpiration not being able to increase without changing our conditions, because the air dissolved in the water becomes disengaged, the quantity of water which arrives at the organs of transpiration across a vessel filled with water is expressed by $\frac{A\,d^4}{l}$. From this we can see why climbing plants have such large vessels; in fact, the increase in diameter can alone compensate that of the length. And, further, the quantity of water which can pass through a vessel in a given time bears a certain relation, varying for each species, with the water which it contains. This, which I have

* See *infra*, p. 389.

called the transpiratory reserve, it might be better to term the vascular transpiratory reserve. I propose to publish a work on water reservoirs in general. A study of this apparatus very often gives the key as to the resistance of certain plants to certain surroundings, and permits us to indicate at once the conditions under which we must cultivate plants. Anatomy, I am convinced, will open the way to rational culture."

Permeability of Wood to Water.*—Examination of the structure of the wood in a number of gymnospermous and angiospermous trees and shrubs has led F. Elfving to the conclusion that the wood loses its permeability for water as soon as the cell-cavities become completely closed. The water of transpiration cannot therefore be conducted through the cell-walls, but filters from cell to cell. In the tracheides of the Coniferæ it is clear that the largest part of the cell-wall serves as a support for the separate tracheides; while the filtration can take place only at definite spots, viz. the bordered pits.

Trichomatic Origin and Formation of some Cystoliths.†—J. Chareyre saw in a very young leaf of *Morus alba* that the hairs, which were very long and a little swollen at their base, were gradually filled with a striated mass incrusted by calcareous matter. With age these hairs become absorbed, their extremity undergoing atrophy, and their lower portion swelling and becoming globular. The cystolithic mass became detached from their walls, and, in the adult leaves, the extremity of the hair disappearing entirely, the basal portion, now inclosed in epidermis, formed a true cystolithic cell. We here, then, have cystoliths which are of epidermal origin and are most frequently developed at the expense of a hair, though in rarer cases from the outer wall of an epidermal cell. There is another category, examples of which are to be found in some Acanthaceæ and Procrideæ, in which the cystoliths exist in all the tissues, and are developed at the expense of the cell which contains them. The two categories may perhaps be connected together by the linear cystoliths of some Ortiæ.

Formation of Starch out of Sugar.‡—J. Boehm contests the ordinary view that the starch formed in chlorophyll-grains is a direct result of the decomposition of carbon dioxide; he believes it to be in many cases formed out of other organic substances, especially sugar, which have found their way into the chlorophyll-grains. Starch is in this way often formed in the absence of light in grains of chlorophyll or of etiolin. In order to confirm this hypothesis, leaves and pieces of the stem of the scarlet-runner, containing no starch, were exposed to the action of a solution of sugar, when they were found, after twenty-four hours, to contain abundance of starch; the quantity depending on the concentration of the solution of sugar; the temperature, between the limits of 10° and 20° C., appearing to make no difference. In leaves of *Galanthus*, *Hyacinthus*, *Iris*, &c., starch was produced in

* Bot. Ztg., xl. (1882) pp. 707–23.
† Comptes Rendus, xcvi. (1883) pp. 1073–5.
‡ Bot. Ztg., xli. (1883) pp. 33–8, 49–54.

the same way in from eight to ten days, as well as in many other cases. The author believes, therefore, that the first demonstrable product of the decomposition of carbon dioxide is not starch, but sugar, and in all probability this is really the first product formed.

Distribution of Energy in the Chlorophyll-spectrum.*—C. Timiriazeff points out the intimate relationship between the absorption of light by chlorophyll and the intensity of the chemical phenomena produced, the curves of absorption of light and of the decomposition of carbon dioxide presenting an almost exact concurrence. This last function may be considered as dependent on the energy of radiation as measured by its effect on the thermopile. Langley has definitely fixed the position of maximum energy in the solar spectrum to be in the orange, exactly in that part which corresponds to the characteristic band of chlorophyll, between B and C.

It results, therefore, that chlorophyll may be regarded as an absorbent specially adapted for the absorption of those solar rays which have the greatest energy; and its elaboration by the vegetable economy is one of the most striking examples of the adaptation of organized beings to the conditions of their environment.

Under the most favourable conditions 40 per cent. of the solar energy corresponding to the rays of light absorbed by the characteristic band of chlorophyll, is transformed into chemical work. Chlorophyll therefore constitutes an apparatus of great perfection, capable of transforming into useful work 40 per cent. of the solar energy absorbed.

Colour and Assimilation.†—T. W. Engelmann has made an extensive use of the so-called bacteria method for investigating the effect of light on chlorophyll-cells, and he now gives further details of his experiments, with some of his conclusions.

The effect of free oxygen upon quiescent bacteria is so great that by their presence the trillionth of a milligram of the gas can be detected. When a green cell in water is evolving oxygen, even to an extremely minute amount, the movements of the bacteria afford instantaneous indication of its presence. Moreover, when the ray of light, shining through or on the green cell, is unfavourable to the process of assimilation and evolution of oxygen, the effect on the bacteria is at once shown. All of Engelmann's experiments were checked by control observations. The results are mainly as follows:—Only those cells which contain particles of coloured protoplasm evolve oxygen in the light. When colourless protoplasm was screened by a coloured solution, or was illuminated by light coming through a green leaf, no oxygen was evolved. It will be seen that this has a direct bearing upon some of Pringsheim's views. In the case of cells of different colours, e. g. green, *Sphagnum* and *Spirogyra;* yellowish-brown, *Navicula* and *Pinnularia;* bluish-green, *Oscillatoria* and *Nostoc;* red, *Callithamnion* and *Ceramium;* distinct relations between the colour and the amount of assimilation under different rays were made out.

* Comptes Rendus, xcvi. (1883) pp. 375–6.
† Bot. Ztg., xli. (1883) pp. 1–13, 17–29.

The maximum activity for green cells was in the red between B and C (the place of the most striking of the chlorophyll absorption bands); for yellowish-brown, in the green, at D $\frac{1}{2}$ E; for bluish-green, in the yellow; for red, in the green. Hence there must be a series of colours other than that of chlorophyll which possess the power of assimilation in different parts of the spectrum. The maximum activity for a given colour is found in rays complementary to that colour. The author gives also an account of the possible bearing of the above on the distribution of organisms at different depths of water.

Occurrence of Allantoin and Asparagin in Young Leaves.* —E. Schulze and J. Barbieri removed branches of the birch, plane, and horse-chestnut provided with buds, and placed them in water at the ordinary summer temperature until growth had ceased in the buds. In the extract from the buds, asparagin could be detected in all three cases. In that from the chestnut there was also an amide with the reaction of leucin, and in that from the plane a substance identical in composition and properties with allantoin, $C_4H_6N_4O_3$.

Cholesterin, Phytosterin, Paracholesterin, &c.†—E. Schulze and J. Barbieri found a considerable quantity of cholesterin in etiolated seedlings of *Lupinus luteus*, the substance obtained from the seeds and cotyledons exhibiting to a great degree its ordinary properties. On the other hand that obtained from the root and tigellum showed essential differences, especially in a considerably higher fusing-point. The authors propose for it the term "caulosterin," and regard it as a distinct member of the group, with the probable formula $C_{26}H_{44}O$. The group will then consist of five members, with the following fusing-points:—cholesterin 145°–146°, phytosterin 132°–133°, paracholesterin 134°–134·5°, caulosterin 158°–159°, and isocholesterin 138°–138·5°.

Respiration of Submerged Parts of Plants.‡—A. Barthélemy records observations on *Nymphæa* and *Nelumbium*, which confirm his previously published view that the disengagement of bubbles of gas is not a normal property of submerged leaves, but is the result of accidental circumstances, and that, in consequence, the special respiration of green leaves has not the importance to the plant which is usually attributed to it.

Freezing of Liquids in Living Vegetable Tissue.§—T. Meehan, referring to the prevalent opinion that the liquid in vegetable tissues congeals as ordinary liquids do, and expanding, often causes trees to burst with an explosive sound, states that experiments on young and vigorous trees, varying from one foot to three feet in diameter, demonstrated that in no instance was there the slightest tendency to expansion, while, in the case of a large maple (*Acer*

* Journ. prakt. Chem., xxv. (1882) pp. 145–58. See Bot. Centralbl., xiii. (1883) p. 263.

† Journ. prakt. Chem., xxv. (1882) pp. 159–80. See Bot. Centralbl., xiii. (1883) p. 264. Cf. Liebig's Ann. Chem., ccxi. (1882) pp. 283–4.

‡ Comptes Rendus, xcvi. (1883) pp. 788–90.

§ Proc. Acad. Nat. Sci. Philad., 1883.

dasycarpum), 3 ft. 11½ in. in circumference, there appeared to be a contraction of 1-8th in. In dead wood soaked in water there was an evident expansion, and the cleavage with explosion, noted in the case of forest-trees in high northern regions, may result from the freezing of liquid in the centre of less vital parts of the trunks. In some hardy succulents, however, instead of expansion under frost, there was a marked contraction. The joints or sections of stem in *Opuntia Rafinesquei* and allied species shrink remarkably with the lowering of the temperature, so that the whole surface in winter is very much wrinkled. Assuming as a fact that the liquids in plants which are known to endure frost without injury do not congeal, it might be a question as to what power supplied the successful resistance. It was probably a vital power, for the sap of plants, after it was drawn from them, congealed easily. In the large maple tree already referred to, the juices not solidified in the tree exude from the wounded portion and then freeze, hanging from the trees as icicles, often 6 in. long.

Influence of Electricity on Vegetation.*—M. Macagno has experimented near Palermo upon the influence of atmospheric electricity on the growth of grape vines. Sixteen feet were submitted to the action of an electric current, by means of a copper wire inserted by a platinum point in the extremity of a fruit-bearing branch, while another wire connected the branch at its origin with the soil. The experiment lasted from April to September. The wood of the branches which were experimented upon contained less potash and other mineral matters than the rest of the vine, but the leaves had an excess of potash under the form of bitartrate; the grapes collected from the electrized branches furnished more must, contained more glucose, and were less acid.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Male Prothallium of Equisetum.†—D. H. Campbell describes the development from the spore of the male prothallium of *Equisetum arvense*. When the spores are sown under glass or on damp earth, they germinate almost immediately. They first put out a nearly colourless rhizoid, the body of the spore then dividing into two cells by a longitudinal septum. Directly after germination, the chlorophyll begins to collect into distinct chlorophyll-bodies; the mode of subsequent cell-division varies considerably; some of the prothallia showing a tendency to branch quite early. Some of the prothallia send out a second rhizoid from one of the lower cells; finally they become somewhat club-shaped. The first mature antherozoids were observed nearly six weeks after the sowing of the spores.

The structure of the antheridium is extremely simple, consisting simply of a cavity or excavation in the end of a branch of the prothallium. It commences by a concentration of protoplasm at the spot,

* 'Les Mondes.' See Journ. Frankl. Institute, cxv. (1883) p. 311.

† Amer. Natural., xvii. (1883) pp. 10–15 (2 pls.).

the cavity being gradually formed, at first indistinct, but finally assuming a nearly regular oval shape. The protoplasm soon breaks up into small round bodies which are discharged as antherozoids. The first antheridia are formed singly; but later two or three are formed almost simultaneously at the end of a single branch. When the antherozoids are mature, the cells surrounding the interior cavity of the antheridium separate, leaving an opening by which they escape. Usually the whole mass of antherozoids is discharged in a few minutes, but sometimes the discharge is more gradual. Each antherozoid is inclosed in, and lies coiled up within, a membrane. After resting for a few moments this sac bursts, freeing the inclosed antherozoid, which immediately swims rapidly away, with a peculiar undulatory movement due to its spiral form. The antherozoids are of comparatively very large size. The body is long and slender, tapering to a point at one end, and bearing the remains of the enveloping sac on the inner side. They are quickly killed by iodine; the cilia becoming rigid, and standing out in all directions from the thicker end of the antherozoid.

Reproductive Organs of Pilularia.*—K. Goebel has examined the development and structure of the fructification of *Pilularia globulifera*.

A longitudinal section of the young fructification shows that the chambers in which the sporangia are formed are not closed, but have an opening at the apex. The chambers are therefore not of endogenous origin, but are merely depressions in the surface. A placenta springs from the outer wall of each chamber in the form of a cushion ascending from below upwards, on which the sporangia are developed, usually in ascending succession. The placentæ are therefore, as in Marattiaceæ, also products of superficial cells.

The four projecting ridges which correspond to the four chambers do not meet in the centre of the fructification, but are separated by a moderately large mass of tissue, which, when the fructification is ripe, separates into four sections. Goebel does not agree with Juranyi in regarding these projections as tips of leaf-segments, but simply as outgrowths of the outer margin of the four pits in which the sporangia are formed. The entire fructification of *Pilularia* is, according to this view, a simple leaf-segment, in depressions of which the sori are developed, as in the homosporous Filicineæ. The central mass of tissue which separates the pits from one another does not at first present any differentiation into four pits. This view of the structure of *Pilularia* is confirmed by a comparison with *Marsilea*.

The idea that the fructification of *Pilularia* is composed of four leaf-segments has originated from the structure of the mature organ, which splits into four parts. But this results from the central tissue between each pair of soral chambers splitting into two. In the centre of the fructification is often a cavity caused by the violent rupture of the tissue; but this was always occupied originally by starch-containing tissue. The lines where the rupture subsequently takes place

* Bot. Ztg., xl. (1882) pp. 771–8 (1 pl.).

are formed of narrow tabular amylaceous cells, and are in direct connection with the placental tissue. The whole of the rest of the tissue goes to the formation of the mucilage which brings about the opening of the fructification.

The tissue bounded by the lines of separation, which surrounds the separate soral chambers, is sometimes termed in *Marsilea* the indusium, a term which is correct physiologically, but not morphologically. It is in the Marsileaceæ formed by differentiation of definite portions of the tissue of the leaf and the splitting up of these; and is not, as in the other Filicineæ, either a development of the surface of the leaf or the recurved margin of the leaf itself. In the pedicel of the young fructification is a vascular bundle, which branches above into two arms; in the mature organ are twelve branches.

The true position of the fructification has been a matter of controversy. When mature it appears as if placed in the axil of a leaf and independently of it. But that it is not in fact axillary is shown by the presence in addition of a true axillary shoot, and also by the structure of the vascular bundles. The examination of young stages shows clearly the foliar origin of the fructification. As in *Marsilea*, the sori of *Pilularia* spring from the upper side of the fertile portion of the leaf; as is shown by the position and structure of the pits.

In all essential points the origin of the macrosporangia and microsporangia corresponds to that in *Marsilea;* and the same is the case with the origin of the sori; in this respect the author differs from Russow's conclusions. The soral canal can be made out at the time when the placenta is being formed, and is a direct continuation of the pits. As in *Marsilea* the placentæ are formed out of superficial cells in depressions in the young fructification, corresponding to the structure in the homosporous ferns and in Salviniaceæ.

Aerial Branches of Psilotum.*—C. E. Bertrand divides the aerial branches of adult *Psilotum* into the following classes, differing in their morphological value:—(1) Aerial branches of the first order: Cladode- or branch-stocks; (2) Aerial branches of the second or a higher order: Cladodes of the order in question; (3) Terminal branches or terminal cladodes; (4) Simple aerial branches; (5) Sporangiferous branches or sporangiferous cladodes.

Underground Branches of Psilotum.†—C. E. Bertrand states that any transverse section of the median region of a simple underground branch of adult *Psilotum* shows the following parts:—(1) A bicentral slightly elliptical vascular bundle, the centre of which corresponds to the centre of the section. (2) A protecting sheath surrounding the bundle. (3) Between this sheath and the superficial layer a thick zone of primary fundamental tissue, not differentiated into distinct layers. (4) A superficial layer of epidermal cells, some of which are prolonged into hairs, separated by a septum from the supporting cell.

The structure of the vegetative tissue of a simple branch remains

* Comptes Rendus, xcvi. (1883) pp. 390–2.
† Ibid., pp. 518–20.

unchanged as long as it continues to elongate, whatever the length of the branch; and the structure of the median region is always the same from the base to the summit. It follows that the tissues at different levels from the vegetative zone indicate the different stages of differentiation in the tissues of any given level of the median region of a simple branch. The cone of growth of a simple underground branch never has a pileorhiza; it is of exogenous origin.

The conclusion drawn from these observations is that the simple underground branches of *Psilotum* are stipites with a single central vascular bundle; these stipites have no appendages or roots, and perform the physiological function of roots. In certain regions the plant is therefore reduced to a condition of extreme simplicity; the stipes playing the part of a root; and the resemblance to a true root is extremely close. Among the Lycopodiaceæ, finally, there are some species entirely destitute of root.

Muscineæ.

Male Inflorescence of Muscineæ.*—H. Leitgeb points out that the order of development from the lower to the higher forms of Muscineæ is indicated by the position of the sexual reproductive organs on the vegetative shoots. The advance may be described as an acropetal movement of development; the reproductive organs originating in segments nearer and nearer to the apex as we ascend in the scale. The shoot loses in consequence more and more of its vegetative character, and becomes differentiated as a special fertile shoot, which again becomes more and more shortened. In the lowest forms of Hepaticæ, the Ricciæ and Riellæ, the vegetative shoot assumes at particular times reproductive functions without essentially altering its character. A good example of a higher stage is afforded by *Plagiochasma*, where the transformation is indicated by the reduction of the assimilating tissue. In the greater number of Muscineæ we get the still higher stage of development, where the vegetative shoot closes with a special "inflorescence" of sexual organs, while in *Marchantia* and *Lunularia* a still more complete differentiation of the fertile shoot takes place. Leitgeb then states that in the true mosses also the first archegonium is derived from the apical cell, and therefore forms the direct conclusion of a vegetative shoot; and argues that in *Polytrichum* the male inflorescence is composed of partial inflorescences, each of which corresponds to a reduced lateral branch; the leaves being simple protective organs to the antheridia.

Antheridium of Hepaticæ.†—H. Satter describes the structure and development of the antheridium in *Pellia*, *Monoclea*, and *Corsinia*. In *Pellia epiphylla* the antheridia are imbedded in the thallus, as in Marchantiaceæ, but are of the true Jungermanniaceæ type; from which he concludes that the depression of the antheridium has no influence on its structure. In *Monoclea* and *Riella*, on the other hand,

* Flora, lxv. (1882) pp. 467–74.

† SB. K. K. Akad. Wiss. Wien, lxxxvi. (1882). See Bot. Centralbl., xiii. (1883) p. 227.

the Marchantiaceæ type of antheridium occurs. The author considers, therefore, that the mode of development of the antheridium cannot be used as a systematic character. The abnormal structure in *Corsinia* is regarded as a reversion, and the mode of development in the Jungermanniaceæ is the older phylogenetically.

Characeæ.

Monograph of Characeæ.*—A MS. by the late A. Braun, edited by O. Nordstedt, gives a monograph of the species of Characeæ, including several forms not previously published. There are here enumerated 70 species of *Nitella*, 8 of *Tolypella*, 1 of *Lamprothamnus*, 3 of *Lychnothamnus*, and 60 of *Chara*. In *Tolypella nidifica* Braun describes, in the mature cells, the original rows of chlorophyll-grains as being no longer clearly distinguishable, their locations being interrupted by large, clear, disk-shaped bodies, which, when the chlorophyll-grains are removed, are seen to be thickenings of the cell-walls.

Fungi.

Physiology of Fungi.†—Gaston Bonnier and L. Mangin discuss the results of their studies on respiration and transpiration in plants without chlorophyll.

Throughout their experiments they found that the volume of oxygen absorbed is greater than that of the carbonic acid produced. Contrary to the results of some other experimenters, they find that, for a given species, there is no sensible variation with a varying temperature, and they ascribe the different result to a neglect by others of the consideration of the phenomena of true fermentation. Differences in hygrometric conditions have a sensible influence on the intensity of the respiratory phenomena. Diffused light diminishes the respiratory activity, and the intensity is greater for the rays of higher than for those of less refractive power. In examining into the question of transpiration they placed the fungi under conditions in which the quantity of water absorbed was very nearly equal to that transpired. After having verified the considerable influence of an elevation of temperature and a depression of the hygrometric conditions, they made an inquiry into the influence of diffused light, which resulted in the demonstration that transpiration is greater with diffused light than in darkness.

Fungus Parasitic on Sponges.‡—J. Dufour has examined the black patches which are formed on skeletons of the officinal sponges which have been in use for some time, and in presence of which they often become useless. He finds the appearance to be produced by a minute fungus which disintegrates the fibre of the sponge, blackening it and producing quantities of dark spores. He assigns this form to the genus *Torula* as a new species, *T. spongicola*. The spores are round or suboval, ·004 to ·007 mm. in diameter. The cell-membrane

* Abhandl. K. Akad. Wiss. Berlin, 1882 (7 pls.). See Bot. Centralbl., xiii. (1883) p. 41.

† Comptes Rendus, xcvi. (1883) pp. 1075–8.

‡ Bull. Soc. Vaud. Sci. Nat., xviii. (1882) pp. 144–7.

of old spores thickens and becomes brown; they often contain a large central vacuole or some oil-drops. Chains of spores or fragments of mycelium are found among them when *in situ*. When cultivated in a detached fragment of infected sponge beneath a watch-glass, the spores germinate, producing either chains of spores or a mycelium, the ramifications of which produce simple or branched strings of young spores by successive budding (by which the terminal spore is always the youngest). The terminal spore not unfrequently gives rise to a mycelium-thread. The fungus has also been cultivated upon gelatine. The reason why it occurs in dense masses on particular parts of an infected sponge appears to be that at such points occur the masses of bacterian zoogloea and remains of sponge-sarcode, which in point of fact are almost always to be found on damp sponges, and that these present favourable localities for the growth of the fungus. Experiments tend to show the presence of soap to be rather unfavourable than otherwise to this organism. From the history of the plant it is easy to understand how one sponge infects another. To cure affected sponges they should be soaked for some hours in somewhat strong solutions of carbolic or salicylic acid, or treated with boiling water.

Glycogen in the Mucorini.*—In continuation of his observations on the presence of glycogen in various plants,† L. Errera now finds it in all the Mucorini which he has examined.

In *Phycomyces nitens* it occurs in the mycelium, fertile filaments, and young sporangia; it appears to pervade the protoplasm, and not to be locally aggregated, as is usually the case in the asci of the Ascomycetes. Its abundance varies in different parts of the cell. When *Phycomyces* is subjected to the action of strong alcohol, the protoplasm contracts, and expels the glycogen, which then distributes itself through the cell-sap, and can be detected by iodine. In very young filaments the glycogen is distributed through the whole protoplasm, but is most abundant in the apical region of the cell; and this is especially the case at the moment when the sporangium is about to be formed. It does not diminish during the formation of the sporangium; and when this is definitely constituted, but before the separation of the spores, it is very rich in glycogen, and but little remains in the filament. In the formation of the spores it is taken up chiefly by their protoplasmic contents, and not by their cell-wall. It is possible that a certain quantity of glycogen is required for the respiratory combustion of *Phycomyces*, and by the growth of the cell-wall of the filament, sporangium, and spores; but the greater part is taken up by the protoplasmic contents of the spores; it probably exists there partly in the form of glycogen, while a portion is transformed into other substances.

Mucor Mucedo and *stolonifer* also contain glycogen, but in smaller quantities than *Phycomyces*, and it is more difficult of detection. Its distribution through the filaments at different stages corresponds to

* Bull. Acad. R. Sci. Belg., li. (1882) pp. 451–7.

† See this Journal, ii. (1882) p. 824.

that of *Phycomyces;* the spores are coloured by iodine a mahogany brown. In *M. stolonifer* it is especially difficult to detect, because of the extreme sensibility of the protoplasm to coagulate with iodine; it permeates the protoplasm of the stolons, fertile filaments, and young sporangia. It accumulates locally in opalescent masses, similarly to the epiplasm of *Peziza* and *Ascobolus;* the cell-walls of the fertile filaments are coloured a dirty rose by iodine.

M. Errera also records the occurrence of glycogen in *Pilobolus crystallinus*, and in other species of the same genus; and in *Chætocladium Jonesii*, *Piptocephalis Freseniana*, and *Syncephalis nodosa* and *minima*.

As a control experiment, glycogen was extracted from the *Phycomyces*, by a method which is described in detail, and recognized by the ordinary chemical tests.

Heterœcism of the Uredines.*—C. B. Plowright gives his experiments on the connection of certain æcidial and teleutosporic forms of *Uredineæ*. His experiments were started in 1881 with cultures of the spores of *Æcidium Berberidis* on wheat; but as *Uredo linearis*, which is the uredo-stage of *Puccinia graminis*, appeared on the control plants as well as on those on which the æcidial spores were sown, he was not able to confirm the connection between *Æcidium Berberidis* and *Puccinia graminis* which is accepted by Continental botanists. In 1882 he repeated his experiments on a larger scale, and with a more satisfactory result. In the case of *Puccinia graminis*, the mildew of wheat, he not only succeeded in producing *Uredo linearis* on wheat by sowing the æcidial spores, the control plants remaining healthy; but he reversed the experiment, and produced *Æcidium Berberidis* by sowing the *Puccinia* spores. He also sowed the spores of *Podisoma Sabinæ* and *P. Juniperi* on pear and *Cratægus* seedlings, and produced *Roestelia cancellata* and *R. lacerata* respectively. The spores of *Gymnosporangium Juniperi*, sent from a distance of several hundred miles, when sown on *Sorbus Aucuparia*, were followed by a growth of *Roestelia cornuta*, a species never before seen by Plowright in Norfolk, where the experiment was made. He also experimented with other species of *Puccinia*, *Peridermium*, and *Uromyces*, and succeeded in confirming the views of Continental writers as to their secondary forms, in one instance producing a *Puccinia* not before known in Britain, and in the case of *Uromyces Junci*, showing the relation to *Æcidium zonale* which was suspected by Fuckel.

No writer since De Bary has shown more successful results in this difficult subject, and Mr. Plowright deserves great praise for his careful experiments. Except in one series of cultures, the fully developed æcidial form was obtained, and not the spermogonia alone, as had been the case with some other investigators. Although most of the experiments were rather in confirmation of those of other botanists, in a very important respect he has added to our previous knowledge. One great difficulty in the way of accepting the connection between *Æcidium Berberidis* and *Puccinia graminis* has been that

* Grevillea, xi. (1882) pp. 52–7. See Amer. Journ. Sci., xxv. (1883) pp. 314–6.

the *Puccinia* is very common in districts where the barberry is unknown, and according to De Bary the *Puccinia* spores cannot be made to germinate and grow upon grasses. Mr. Plowright, however, was able in a limited number of cases to make the *Puccinia* spores grow upon wheat, especially on young seedlings.

Infectivity of the Blood.*—G. F. Dowdeswell discusses the infectivity of the blood and other fluids in some forms of septic disease, and the reputed occurrence therein of an increase of virulence in successive inoculations, and he comes to the conclusion that in the cases in which he has experimented, Davaine's septichæmia in the rabbit and the so-termed Pasteur's septichæmia in the guinea-pig, there is no increase of infective virulence in the septic fluids in successive generations, either in respect to the minimal quantities required in the incubation period, nor as to any constant difference in the length of the incubation period. Inflammatory products are more variable, and this is probably partly due to differences in the severity of the cases affording the infective matter (Burdon-Sanderson), and partly, as the author states, to constitutional idiosyncrasy in the animal inoculated. In Davaine's septichæmia there can be little doubt but that the microphyte constitutes the actual contagium, but in Pasteur's septichæmia the microphyte is not simply or *per se* the contagium, though, no doubt, it may modify the pathological conditions. The author states that he has relied greatly on the Microscope, and he looks to the use of its greatly increased powers for the advancement of our knowledge of this subject.

New Species of Micrococcus.†—T. J. Burrill describes *M. amylivorus*, found in the tissues of plants, and causing the so-called "fire-blight." By the action of this organism the stored starch is destroyed by fermentation, and carbonic acid, butyric acid, and hydrogen given off. It may be cultivated in pure starch in water at a moderately warm temperature. *M. toxicatus* is found in species of *Rhus*, and is believed to be the peculiar "poison" for which these plants are known. If transferred to the human skin they multiply rapidly, penetrate the epidermis, and give rise to inflammation. *M. insectorum* has been found in the digestive organs of *Blissus leucopterus*; the insect may be sometimes observed to die off in great numbers, and to present every appearance of suffering from a contagious disease, of which these organisms are no doubt the true element. The name of *M. gallicidus* is given to the organism which appears in the blood of the domestic fowl when suffering from "chicken cholera," and which, though often described, does not seem to have been ever named. Similarly the name of *M. suis* is given to the form which appears to be the dangerous element in "hog cholera."

Influence of Light on the Development of Bacteria.‡ — In connection with the sanitary state of the hospital at Melbourne, J. Jamieson has carried out a series of experiments on this subject. He inoculated

* Proc. Roy. Soc., xxxiv. (1883) pp. 449–69.
† Amer. Nat., xvii. (1883) pp. 319–20.
‡ Proc. Roy. Soc. Victoria, June 8, 1882.

Cohn's solution with drops of putrid flesh-liquid full of *Bacterium termo*. The questions which he endeavoured to solve were:—1. Whether ordinary diffused light exercises any influence on the development of bacteria in Cohn's solution; 2, whether any influence is produced by the direct rays of the sun; 3, whether the direct rays of the sun rapidly kill bacteria in a dry state. In accordance with earlier observations, it was first ascertained that the bacteria were killed by direct but not by diffused sunlight. Experiment was then made as to the effect of temperature on these results; and the conclusion arrived at was that at moderate and low temperatures the direct rays of the sun not only do not kill bacteria, but even have no prejudicial influence on their development. This will account for the want of harmony in the results of previous experiments.

As regards the effect of direct sunlight on dry bacteria, Jamieson arrived at the conclusion that, under conditions very favourable for rapid and complete drying up, as when the bacteria are freely exposed to both sun and air, they may be destroyed in a comparatively short time, which, however, is not less than from two to four days, even in summer. Any direct influence of the rays of light as such on bacteria must therefore be regarded as not established.

Bacteria connected genetically with an Alga.*—Among the algæ which abound on the damp walls of greenhouses, one of the commonest is, according to H. Zukal, *Drilosiphon Julianus* Ktz., belonging to the Scytonemeæ, and distinguished by its thick outer calcareous sheath, which is partially or entirely wanting in places. The filaments have a tendency to produce hormogonia of two different kinds. In the formation of the most common kind, the filament within the outer sheath splits up into small pieces, which ultimately escape, and each carries on an independent existence. These develope into filaments which again produce hormogonia; but in this process the original comparatively thick form of filament is never reproduced; each resulting filament is slenderer than the last; till finally they become invisible except to the highest powers. The second kind of hormogonium has a fusiform shape, and thick brownish cell-wall, and consists usually of from four to eight cells. These may remain dormant for a long time after their escape from the sheath, and may hence be termed resting hormogonia. On germinating, they reproduce the ordinary thick filaments.

The gradually thinner filaments resulting from the ordinary hormogonia manifest a tendency for their constituent cells to separate within the external sheath in a moniliform manner, which becomes more pronounced in the succeeding generations, the sheath at the same time gelatinizing, and the whole organism assuming a nostoc-like character. The cells finally become differentiated into larger and smaller, and in this state the filament is known as *Nostoc parietinum* Rabenh. The cells of the filament eventually separate, and assume the character of an *Aphanocapsa*. Or in other cases *Glœocapsa*-like structures result from the nostoc-filaments, which constitute

* Oesterr. Bot. Zeitschr., xxxiii. (1883) pp. 73–8 (1 pl.).

the *Glœocapsa fenestralis*; or very slender threads are produced, the *Leptothrix parasitica* Ktz. The identity of this form with *Drilosiphon* has been fully established by the author; instances are not infrequent where a filament which is at the base a typical *Drilosiphon* terminates at the upper end in a *Leptothrix* thread, then described as *Leptothrix muralis* Ktz.

These leptothrix-hormogonia have a tendency to break up into detached cells, some of which soon assume a rapid motion and partake altogether of the nature of a vibrio. Others again agree altogether with the structure and phenomena exhibited by *Bacillus subtilis* Cohn, closing with the formation of spores and micrococci. The germination of these has not been followed.

Bacterial investigation of Sunlight, Gaslight, and the light of Edison's Lamp.*—T. W. Engelmann continues his investigation of the quality of different lights, as displayed by the difference in their effect on the assimilating powers of bacteria. He finds that the relationship between the assimilating effects of different wave-lengths of sunlight, and the effect of corresponding wave-lengths of gaslight on green, yellow, and blue-green cells of plants, is the same. The following are given as the numbers for the assimilating effects at four different spots of the prismatic spectrum of sunlight and gaslight respectively:—

(*a.*) *With Green Cells.*

	B¼ C.	D.	E¼ *b*.	F.
Sunlight ..	100 (61)	34·0 (56)	13·9 (44)	24·6 (38)
Gaslight ..	100 (208)	22·4 (111)	5·6 (105)	3·8 (50)

(*b.*) *With Yellow Cells.*

	B¼ C.	D.	E¼ *b*.	F.
Sunlight ..	100 (50)	55·1 (47)	40·5 (21)	40·4 (7)
Gaslight ..	100 (196)	35·1 (136)	15·5 (65)	7·6 (70)

(*c.*) *With Blue-green Cells.*

	B¼ C.	D.	E¼ *b*.
Sunlight ..	100 (29)	75·4 (32)	19·9 (24)
Gaslight ..	100 (113)	50·7 (99)	7·6 (49)

The figures between brackets denote the number of measurements, from the average of which the numbers are derived.

If from these numbers the relative assimilating energy of gaslight is calculated in a percentage of the energy of the corresponding wave-lengths of sunlight, the two energies being taken as equal in B½ C, the following results are obtained:—

With green cells;	65·9	per cent. at D;	40·4	per cent. at E½ *b*;	19·5	per cent. at F.
„ yellow „	63·7	„	38·3	„	18·8	„
„ blue-green „	68·8	„	38·2	„		

The coincidence between the corresponding numbers in these three rows is so great that, reckoning possible sources of error, they

* K. Akad. Wetensch. Amsterdam, Nov. 25, 1882. See Bot. Centralbl., xiii. (1883) p. 214.

may be regarded as identical. It furnishes at the same time an objective proof of the practicability of the bacterial method for quantitative photometric determinations.

These figures confirm the long-known result that the energy of gaslight falls rapidly at the most refrangible end of the spectrum, in comparison to sunlight. This fall does not, however, appear to be so rapid with the clear white flame of a large Sugg's burner as with a Bunsen burner.

The light of an Edison's lamp, produced by a constant stream from twenty Grove's elements, has a similar effect to that of a Sugg's burner. Their relative assimilating energies with a green alga (*Scenedesmus quadricaudatus*) were determined immediately after one another at four different spots of the microspectrum, as follows:—

	B½ C.	D.	E½ *b*.	F.
Gaslight ..	100 (5)	15·1 (5)	4·2 (4)	2·9 (3)
Edison's light	100 (5)	15·5 (5)	4·3 (6)	3·0 (6)

The absolute energy of Edison's lamp was somewhat less than that of Sugg's burner.

Microbia of Marine Fish.*—At the zoological station recently established at Havre, L. Olivier and C. Richet have carried on an extensive series of experiments on the presence of microbia in the tissues of living fish. With one or two exceptions, they find these organisms universally present in the peritoneal fluid, the lymph, the blood, and, in consequence, in the tissues. They have all the characters of terrestrial microbia, and are reproduced in the same way, by division and by spores. They are most numerous in the peritoneal fluid, less so in the blood and lymph.

The most common form is that of bacilli, longer or shorter, endowed with oscillatory movements; they are coloured by ammonium picrocarbonate and by aniline pigments; some are provided with spores, either in the middle or at the extremity of the rod.

Movements of Minute Particles in Air and Water.†—C. v. Nägeli discusses the laws which regulate the ascending, descending, and dancing movements and the power of floating of minute particles in air and water, as bearing on the question of the transport of the pathogenous Schizomycetes. The movements depend entirely on currents of air, combined, in the case of descending movements, with the attraction of the earth. If there is no current in the air below a certain minimum rapidity, the air once free of fungus-germs must remain free as long as these conditions last. This minimum rapidity is estimated at 2 cm. per second. The movements of minute particles in water are subject to much more complicated laws. The passage of particles such as the Schizomycetes and other fungus-spores from water to air takes place by the drying of moist surfaces, not by simple evaporation from the surface of a fluid; also by the bursting

* Comptes Rendus, xcvi. (1883) pp. 384–6.

† Untersuch. über niedere Pilze aus dem pflanzen-phys. Inst. München, i. (1882) pp. 76–128. See Bot. Centralbl., xii. (1882) p. 345.

of bubbles, by which particles of water are violently thrown into the air.

Miquel's 'Living Organisms of the Atmosphere.' * — Aërial micrography is a study of comparatively recent date, and so beset with difficulties that we hail with pleasure the advent of a work devoted exclusively to the subject, especially from the pen of Dr. Miquel, who for several years, as chief of the micrographic staff at the Observatory of Montsouris, has contributed important articles to the Annuaire de l'Observatoire de Montsouris, Paris. As far as we know it is the only work that embraces comparative seasonal and statistical data. The first attempts of this kind were made we believe in this country by Dr. R. L. Maddox in 1871, who for several months counted, tabulated, cultivated, and figured the air-borne germs entrapped by a self-acting vane or "Aeroconiscope," figured in the Monthly Microscopical Journal, June 1870. Owing to the little interest which then existed upon this subject, and the increasing labour it needed, he was obliged to relinquish the study. It was then taken up in a more comprehensive manner in 1872 by Dr. D. Douglas Cunningham of the sanitary service of the Government of India, and the results officially published at Calcutta. The subject has fortunately appeared of such importance to the municipal authorities in Paris, as to lead them to create for it a special department, and they have been most fortunate in selecting Dr. Miquel, who has brought to the task untiring energy, skilful manipulative talent, and unbiassed predilections, his sole aim being to arrive by repeated careful observations at some useful data in connection with the floating morbific matter of the air. To attain this object much laborious work is still required. The author now gives us, from his collated researches, a better knowledge of the various microbes to be found in the air, the best method for collecting them and studying their action upon solutions of different materials, and the effect of recognized so-called antiseptics upon the life of the different organisms.

After sundry trials Dr. Miquel set up his permanent aëroscope and aspirators at the park of Montsouris, which became the basis for comparisons of the number and kind of microbes found in the air at different localities, the air of sewers, hospitals, cemeteries, and apartments, as also that of the laboratory in daily use: and some startling results were obtained. The floating air-dust was collected and examined at every forty-eight hours' interval. A formula was established for counting the number of spores, &c., found in a given space on the surface of the glass that retained them, and corrected for the quantity of air drawn through the aëroscope in a given time. The dusts that had settled in undisturbed places, in apartments, in the laboratory, &c., were examined and contrasted. The infective powers of the soil and of the waters of the Seine and of sewers were compared, and lastly a method of fractional cultivation in certain special sterilized liquids or broths was adopted. The experiments have accumulated

* Miquel, P., 'Les Organismes vivants de l'Atmosphère,' Paris, 1883, 308 pp. and numerous figs.

to the number of very many thousands. The effects of rain and dryness, heat and cold, upon the number and kind of the atmospheric germs drawn into the aëroscope are given statistically; the months and seasons are compared amongst themselves and with previous years. Dr. Miquel employs means for comparisons, and shows some interesting coincidences, as the increase in the number of atmospheric germs and the increase of the death-rate at certain times, though he does not say they stand related as cause and effect. Long and patient inquiry is necessary, and an unbiassed judgment in the examination of this special point. It would be impossible in the short space we can devote to it to deal with the details contained in this excellent work, replete with illustrations of different germs and various forms of apparatus employed for collecting, sterilizing, and cultivating. Mention is made of the improvements in the apparatus as the difficulties increased, and we believe that much more delicate and elaborate instruments and selected cultivating fluids are now in use for dealing especially with the bacterial element of the air, to which much attention is at present being given by the medical profession, especially in relation to the bacillus of tubercle.

It is to be regretted that a similar department is not created in this country, which is supposed to lead in all matters connected with hygiene, and that some basis upon which to carry out the objects in view is not established by different governments in the hope of attaining, if possible, to better preventive measures against zymotic and contagious diseases. Such works as the present will lead us nearer to the realization of more effective measures for the prevention and extension of disease, whether of plants, animals, or man.

Lichenes.

Reproductive Organs of Lichens.*—The most recently published part of Minks's 'Symbolæ licheno-mycologicæ' treats of the Hysteriaceæ, Acrospermeæ, and Stictideæ. The author still maintains his opposition to the view that a lichen is a compound organism, made up of a fungus and an alga.

On the asci and paraphyses together Minks bestows the term "thalamium"; the "thecium" being that portion of the apothecium which includes these organs. The structure of this portion of the lichen may be referred to three different types:—(1) the asci and paraphyses are both fertile hyphæ, which, in the latter case, have undergone arrest of development; and there are all intermediate stages between the two. (2) The paraphyses are formed a shorter or longer time before the fertile hyphæ. They are at a certain period indistinguishable from the hyphæ of the fundamental tissue of the fructification, and there is here no true thalamium. To this class belong the true Stictideæ and the greater part of the Hysteriaceæ. (3) Certain genera exhibit an intermediate structure between the first and second.

* Minks, A., 'Symbolæ licheno-mycologicæ.' Part II. Cassel and Berlin, 1882.

The structure and mode of formation of the spores are described in detail; and it is shown that in the anthonimorphous type (*Hysterium Smilacis*, *Stictis versicolor*, &c.) the mother-membrane takes no part in the abstriction of the spores; but that a new membrane is formed, the old one becoming gelatinized. The formation of the multicellular filiform spores of *Habrostictis rubra*, *Stictis nivea*, &c., is also described in detail.

The germination is described of the spores of *Lophium læviusculum*. After the destruction of the asci, the spores remain for a shorter or longer time in the fructification, where they germinate; passing over ultimately into a chroolepis-like gonidema, and not, as would be the case if Schwendener's hypothesis were true, developing into a fungus.

The two different forms of ascus correspond to the two different forms of spore. When the ascus has a double wall, the inner layer of which ultimately gelatinizes, then the spore has only a single membrane; while when the ascus has only a single wall, the spores have a double membrane, the outer layer of which gelatinizes.

Algæ.

Chromatophores of Algæ.* — By the term Chromatophores, F. Schmitz designates chlorophyll-bodies, coloured (not green) pigments, and other analogous colourless bodies. With the exception of the Phycochromaceæ, all algæ possess chromatophores—the colour never being due to a green cell-sap—though they are often difficult to detect from the delicacy of their envelope or from their being concealed by other cell-contents.

The form of the chromatophores is very various, but remains constant for the same species, and furnishes also distinguishing characters for the genera. Their arrangement is either irregular or more or less regular. In the latter case they may form straight rows, as in Characeæ; beautiful nets, as in the medullary cells of the stem of *Laurencia*, &c.; or curves, as in many Florideæ, &c. &c. They are never in direct contact with the cell-wall or cell-sap, but are always surrounded by a thin, often scarcely perceptible layer of protoplasm.

The living chromatophore has, as a rule, a perfectly homogeneous appearance; but those of *Spirogyra majuscula* exhibit, under high powers, an evident punctation. A similar structure is often visible after fixation with picric acid; in other cases they appear, after hardening, to consist of a uniformly dense and very opaque substance. The wide-meshed reticulate appearance which they assume after treatment with acids and other reagents is the result of disorganization.

The colourless ground-substance of the chromatophores agrees altogether in its reactions with the cell-protoplasm, and is simply a portion of it adapted for special functions. Sometimes it constitutes the whole chromatophore, which is then colourless; but this, which is very frequent with the higher plants, occurs but rarely with algæ.

* Schmitz, F., Die Chromatophoren den Algen, 180 pp., 1 pl., Bonn, 1882. See Bot. Centralbl., xiii. (1883) pp. 289–94.

As a rule they are permeated by green, brown, or red pigments, with which oily substances are possibly mixed. The chromatophores of certain groups of algæ are characterized by containing a colourless strongly refractive substance, which exhibits a striking resemblance to the chromatin-bodies of the cell-nucleus in its reactions, and especially in its behaviour towards pigments. These bodies, which are of by no means universal occurrence among algæ, and which have elsewhere been observed only in *Anthoceros*, are termed by the author Pyrenoids.

Pyrenoids occur in brown, red, and green algæ; they have usually a spherical form, and are imbedded, either singly or in rows, in the substance of the chromatophore. In the green algæ they are commonly surrounded by starch, and then constitute the starch-generators. They result from the formation of starch-grains in the substance of the chromatophore, in close proximity to the pyrenoid; they are at first distinct, but finally coalesce into a hollow sphere. True starch-generators are wanting in the red and brown algæ and in *Euglena*.

Pyrenoids are capable of growth and of division; they result from the division of other pyrenoids, rarely from rejuvenescence. They divide by constriction. When enveloped by a layer of starch, compound pyrenoids sometimes arise from division, without the envelope dividing at the same time.

The chromatophores vary in form, size, and colour according to their age. In young cells they are often smaller, paler, and of simpler structure than in the mature parts of plants; in other cases they lose their colour, as in many hairs and rhizoids, and in secondary meristem. In the antheridia of Characeæ they are at first colourless, afterwards red. They have only a limited power of growth before dividing. They divide either by constriction or bisection; but there is no sharp distinction between the two modes; or occasionally by multisection. The division of the pyrenoid or starch-generator precedes that of the chromatophore.

The chromatophores always increase in number by division, never by rejuvenescence from the cell-protoplasm; as can easily be proved in the simpler forms; with greater difficulty in the case of multicellular algæ. The chromatophores of apical cells and of meristem are the direct result of the division of similar structures occurring in the reproductive cells. In certain cases, as in male sexual cells and in many hairs, they are resorbed. Where both sexual cells contain chromatophores, they may either coalesce or remain distinct after conjugation.

The author regards the chromatophores as an essential constituent of the cell in algæ, never absent except when the cell is destined to a special biological function, for which their possession would be unnecessary.

As regards inclosures in the chromatophores, true starch-grains occur only in the green algæ, and there in most species. As a rule it is only green—but in the central cells of Characeæ colourless—chromatophores that have the power of forming starch-grains. They are either distributed uniformly through the entire mass of the

chromatophore, and then may ultimately completely replace it, or are formed only on the surface of the pyrenoids. Both modes may occur in the same chromatophore.

The starch-grains of Florideæ differ from ordinary starch-grains by the brown or red colour imparted to them by iodine. Their mode of formation is also peculiar, being produced not inside but outside the chromatophore. In the Phæophyceæ starch-grains are formed, as in the Florideæ, around the chromatophore, but they are not coloured at all by iodine.

The "paramyl-grains" of *Euglena* and similar organisms are chiefly distinguished from ordinary starch by not being coloured by iodine; they are produced, like the starch-grains of red and brown algæ, outside the chromatophore. They form a closed envelope round it, completely resembling that of true starch-generators. The pseudo-starch-generators of certain Florideæ, e.g. the Nemalieæ, have the same origin.

In some chromatophores the starch is replaced by substances soluble in alcohol, occurring in the form of small drops on the surface, never in the interior. They may also occur in addition to starch.

Finally, the author compares the chromatophore with the cell-nucleus. Both are composed of a reticulate framework, closely resembling protoplasm in its properties. The nucleoli, or inclosures in the nucleus, agree in their reactions and behaviour with the pyrenoids of many algæ. Both arise only by division, never by rejuvenescence. Nuclei and chromatophores may be regarded as two series springing from a common origin, but developing afterwards in different ways to adapt them to different biological functions.

Phycochromaceæ.*—Proceeding with his detailed account of the Phycochromaceæ, A. Borzi now describes the two families Rivulariaceæ and Chamæsiphonaceæ. The former consists of the following genera:—*Calothrix* Thr., *Sacconema* nov. gen., *Leptochæte* nov. gen., and *Rivularia* Roth. The two new genera are thus described:—

Leptochæte. Trichomata simplicia, sæpius tenerrima, erecta, thallum indefinite crustiforme, tenue, plerumque late effusum efficientia; heterocystis nullis. Multiplicatio hormogoniis et conidiis chroococcoideis ex articulorum basalium transmutatione ortis. Three species:—*L. crustacea, fonticola,* and *parasitica.*

Sacconema. Trichomata irregulariter cæspitoso-aggregata, 2–plura vagina communi fuscescente, lamelloso-stratificata, valde ampliato-saccata, demum apice soluta, involuta et thallum exiguum gelatinosum laciniato-lobulatum constituentia; pseudo-ramulis brevibus, moniliformibus, discretis, heterocystide basilari globoso instructis; sporis aureo-fuscis, articulos vegetativos duplo superantibus, exosporio crassiusculo, scabro. One species:—*S. rupestre.*

The new family of Chamæsiphonaceæ consists of the genera *Chamæsiphon* A. Br., *Clastidium* Kirchn., *Cyanocystis* nov. gen., and *Dermocarpa* Crouan. It has the following diagnosis:—

* Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 272-315 (2 pls.).

Algæ typicæ unicellulares, aquæ dulcis incolæ, rarius marinæ, contento phycochromaceo, subhomogeneo, cæruleo v. violaceo aut chalybeo-purpurascente. Cellulæ vegetativæ globosæ, sæpe minutæ, primum liberæ et in familias chroococcoideas consociatæ, deinde stipite obconico plerumque exiguo, substrato adfixæ, et in coccogoniis globosis v. piriformibus aut plus minus elongato-cylindraceis transmutatæ. Conidia 4–plura in quoque coccogonio, contenti divisione repetita binaria, modo totali, modo partiali et basipeta ortis, demum, membrana matricali ad apicem soluta, raro transverse scissa, liberata.

The author prefers the term *coccogonium* to sporangium for the conidiferous cells of this family. The new genus is described as follows:—

Cyanocystis. Coccogonia globosa aut subglobosa, plerumque sessilia, substrato arcte adhærentia; membrana tenui, dein transverse scissa. Conidia 4–8, raro 16, e contenti divisione totali ad tres directiones alternante orta. One species:—*C. versicolor.*

Bangiaceæ of the Gulf of Naples.*— G. Berthold publishes a monograph of the species of Bangiaceæ found in the Bay of Naples, belonging to the genera *Bangia*, *Porphyra*, and *Erythrotrichia*, with the addition of the anomalous genus *Goniotrichium*.

The structure of the thallus in the first three genera is explained in detail, including the non-sexual spores or tetraspores. They are described as having a spontaneous motility for about forty-eight hours after their escape (in the case of *Bangia fusco-purpurea*), at the expiration of which period they begin to germinate. They do not, however, exhibit any amœboid change of form.

The male organs or "spermatia" of *Porphyra* and *Bangia* exhibit a close resemblance to those of other Florideæ. In *B. fusco-purpurea* and *P. laciniata* they proceed, as a rule, from all the cells of certain individuals; in *P. leucosticta* from parts only of the thallus, which may be regarded as male; the rest of the thallus producing non-sexual spores or procarps, among which the male cells are dispersed in different ways. There are also intermediate structures between non-sexual spores and spermatia. In *Erythrotrichia* the spermatia and non-sexual spores are formed in precisely the same way. In none of the genera have the spermatia any spontaneous motility; in *Erythrotrichia* they are larger than in the two other genera.

The formation and structure of the female cells or procarps is also described in detail, as well as the process of fertilization, resulting in the production of cystocarps. The procarp-cells differ in no essential respect from ordinary vegetative cells. The usual number of cystopores formed is 8, the "octospores" of Janczewski; but they may be only 4 or 2, or possibly only a single one. In female specimens of *P. laciniata* the ripe procarps have a blackish, the ripe cystospores a beautiful red colour; while the unfertilized and perishing procarps go through various green and yellow tints, finally becoming colourless.

* Berthold, G., 'Fauna u. Flora des Golfes von Neapel. 8te Monographie: Bangiaceen. Herausgegeben von der Zoolog. Station zu Neapel.' 28 pp. (1 pl.). 4to, Leipzig, 1882.

The author regards the non-sexual spores, spermatia, and cystospores of the Bangiaceæ as undoubtedly homologous, the procarp corresponding to the mother-cells of the non-sexual spores and of the spermatia. It follows that the procarp is homologous, not with the oosphere of the Chlorosporeæ and Melanosporeæ, but with its mother-cell.

The germination of both kinds of spore has been well followed out.

The above details show that the Bangiaceæ constitute unquestionably a lowly organized family of Florideæ. The true position of *Goniotrichium* must at present remain doubtful; the non-sexual spores correspond closely to those of Bangiaceæ; but no mode of sexual reproduction is known.

Sphærozyga Jacobi.*—P. Richter now identifies the rare nostoc-like alga *Sphærozyga Jacobi* Ag. with *Cylindrospermum polyspermum* Ktz.; and since Wittrock has shown good ground for regarding *Trichormus* Rlfs., *Dolichospermum* Thw., *Sphærozyga* Rlfs., and *Cylindrospermum* Rlfs., as subgenera of *Anabæna*, it must in future be known as *Anabæna* (*Sphærozyga*) *Jacobi*.

Algoid Structures in the Coal of Central Russia.†—P. F. Reinsch states that the combustible substance of coal consists of various bodies of constant microscopical composition. They exhibit no crystalline character, but the arrangement of their particles is nevertheless so uniform that it is difficult to assign to them any but an organic origin. They are not completely decomposed and carbonized, exhibit a certain elasticity, and with a very dilute solution of caustic alkali they manifest a certain power of swelling, similar to many cartilaginous algæ belonging to the Melanospermeæ and Phycochromaceæ, as *Scytonema*, *Hormosiphon*, and *Hopalosiphon;* with iodine they take a distinct yellowish brown colour. These characteristics strongly indicate that they are remains of algæ.

Along with these bodies are found others, probably unicellular, of triangular shape, and manifesting uniform trisection, the nature of which is more obscure, but which are also probably of algoid origin. They are quite distinct from the spores of vascular cryptogams, with which they are often intermixed.

Decomposition of Synedra radians by Caustic Potash.—C. J. Müller calls attention to the action of a solution of caustic potash on the frustules of *Synedra radians*, fresh gathered, or, at least, in a living state. The solution used is composed of 50 grains of caustic potash dissolved in 1 ounce of distilled water.

Having placed the diatoms (more or less intermixed with other forms) in a moist state upon a glass slide, and allowed the mass to get nearly dry, apply the solution of potash freely and cover with thin glass. After the lapse of a few hours (more or less according to temperature) it will be seen—in the case of a front view of a frustule—

* Hedwigia, xxii. (1883) pp. 3–6.
† Flora, lxvi. (1883) pp. 113–20 (2 pls.).

that the connective will separate as two fine siliceous films in a curved form, one belonging to one half of the frustule, the other to the other half.

In the case of a side view of a frustule in the process of division, the two portions will separate at the extremities, expanding therefrom in a curvilinear form.

After a further time it will be seen that the portion of the siliceous shell which contains the striation will be entirely separated from the endochrome, and in many cases greatly curved.

After the lapse of 24 or 36 hours, it will generally be noticed that the siliceous portion containing the striation has broken up into fragments which are exactly like the iron cramps of carpenters. In fact, the striation is due to the juxtaposition of a number of these little cramps along the length of the frustule, probably cemented together originally.

Synedra radians may be described as a long four-sided box, two of the sides (top and bottom) consisting of a siliceous film without any markings, and the other two sides of a structure made up of cramps holding the upper and lower side in position.

Mr. Müller adds: "I should have liked to illustrate this discovery, but any one familiar with microscopical manipulation will be able to see all that I have described better on the stage of the Microscope than in a drawing on paper. A power of 250 or 300 diameters is sufficient for the observation. The success of the experiment depends a great deal upon temperature, the purity of the potash, and the condition of the diatoms. I can lay down no positive rule regarding this, but can only recommend the experimenter to try again when he fails in the first essay."

New Xanthidium.*—W. Archer notices a minute desmid of rare occurrence; one of those, in their way, interesting forms as to which a decision is difficult as regards their generic position. When met with on the few occasions on which he had detected it, though then in some quantity, he had marked the collecting-bottle "Acute-angled *Cosmarium*"; but, as a matter of fact, and taken strictly, the form seemed to fit more properly in the genus *Xanthidium*. It is very minute (about the size of *Cosmarium tinctum*), semicells elliptico-hexagonal, the apices bearing at each side, and at the upper very obtuse angles, a minute but very appreciable mucro, each front surface of each semicell showing a distinct median papilla; end view compressed, showing at the middle on each side the very distinct and prominent papilla. Thus the essentials of the genus *Xanthidium* were fulfilled; for, though the spines were reduced to a minimum, they were there, albeit very minute and acute; and whilst the conspicuous central boss or elevation, bordered by papillæ or ornamented by scrobiculi of the larger forms, was reduced to a simple papilla, yet it, too, was there. It is true that many minute forms, distinctly *Cosmaria*, have a similar median papilla; yet Mr. Archer would lean to the view that, coupled therewith, the presence of the spinules at

* Ann. and Mag. Nat. Hist., xi. (1883) pp. 285-6.

the corners must compel us to regard this form as a *Xanthidium*, of which genus it would certainly be the most minute species, and might stand as *Xanthidium concinnum*.

Structure of Diatoms in the Jutland "Cement-stone." * — Dr. E. van Ermengem gives the results of the investigations of himself and M. Prinz on this subject. The phenomena of diffraction produced by the structural elements of the valves of some very finely marked diatoms, such as *Pleurosigma*, prevent an exact appreciation of their form. The hemispherical granulations which, in the opinion of most diatomists, would produce these markings, do not exist according to others, and Prof. Abbe himself thinks that they are not due to elevations or spherules. Neither is it probable that all diatoms have the same structure; O. Müller, A. Schmidt, and Flögel admit as many as four or five different types.

In their researches the authors have used those species whose structure is least delicate, such as *Coscinodiscus Oculus-Iridis* Ehrg. and *Trinacria Regina* Heib., which are very abundant in the diatomiferous rock at Für (Jutland). In studying the valves in media of various indices of refraction, they obtained a series of optical reactions which indicate that the valves are perforated with very fine apertures. The results of this examination entirely agree with those of other methods of research, especially with those given by the study of sections of the frustules made in different directions. The calcareous rock in which they are imbedded is well adapted for polishing and the preparation of exceedingly thin slices; and the normal or oblique sections of the diatoms obtained by these means can be studied in the calcareous matrix or in different media after the solution of the calcite. It is easy to avoid all rough manipulation which might alter their structure. Mounted in a liquid of high refractive index (1·68), such as the saturated solution of iodide of mercury in iodide of potassium (Stephenson), they give images of remarkable clearness. It is evident on an examination of the slightly oblique sections, that the valves of *Coscinodiscus* are composed of two layers; the upper layer shows hexagonal alveoli, the lower layer is formed by a very thin membrane perforated with very small circular apertures. The apertures are surrounded by a thickened annular edge. This layer, when detached from the subjacent calcite by the wearing away of the rock, leaves very evident impressions, which do not correspond either with the convexities or the concavities of its lower surface.

The thinnest normal sections, the thickness of which is less than the half of an alveolus, prove still more clearly the existence of apertures in the lower layer: the membrane which closes the bottom of the alveoli is manifestly interrupted in its centre, and this lacuna is included on every side between three swollen portions whose section more or less resembles a crescent.

Sections of *Trinacria* show also the existence of pores traversing the entire thickness of the siliceous envelope.

The appearance presented by the double connectives of *Coscino-*

* Bull. Soc. Belg. Micr., ix. (1883) pp. 53–7.

discus in normal sections shows that their growth is at the free edge (Wallich), and not by intussusception or the addition of a third internal connective (Cox). The newly formed valves consist of a single very thin and perforated layer of silica; their development is centrifugal (O. Müller). In some preparations the internal surface of the valves of *Trinacria* is covered with a black and opaque membrane, showing the same perforations. It is probably the lowest layer of the cellular envelope, slightly silicified or even entirely organic, reduced to the condition of carbon by a slow combustion of its cellulose. The existence of this layer is admitted by many authors (Dippel). Chemical analysis proves, moreover, that this blackish substance is charcoal. Inside the frustules it presents the appearance of rounded spheroids; sometimes it completely fills them. In a normal section of *Coscinodiscus* it is established that it stops up the perforations of the lower siliceous layer of the valves, and pushes prolongations into the hexagonal cavities of the alveolar layer.

Amongst the mineralized diatoms found in the London clay, and in which the silica has been replaced molecule by molecule by iron pyrites, there are found some also showing perforations (Kitton). Certain *Coscinodisci*, closely resembling the species from the rock at Für, often show, after cleavage, the lower layer and its perforations. The sections of this clay which the authors are about to undertake will render this demonstration still more clear.

Motion of Diatoms.*—The following statement by Mr. C. Onderdonk must for the present be received with some caution :—

"The motion of diatoms is caused by what I will call the motile *pallium*—a gelatinous, invisible envelope, that entirely envelopes the diatom in the case of the strong-moving *Naviculæ*, but only partially in the case of other forms of weaker motion. This is no mere theory, though I had worked out the theory long before I succeeded in making the pallium plainly visible, and turned my whole attention to staining the motile matter long before I saw a trace of it. I have at length succeeded in staining, hardening, and detaching the pallium, and I now have many of them mounted, also many diatoms, in all stages of disrobement, if I may use the term. The pallium is folded to the diatom in many minute corrugations. Under the action of the reagent, the minute corrugations slowly begin to expand out from the diatom like pseudopodia; longer and longer they grow, but soon we see they are not pseudopodia, for they straighten out into a membrane. The unfolding mantle splits along the midrib, and, in some cases, leaves the flinty shell. This is not the membrane spoken of as investing the diatoms by many investigators, as this is at once destroyed by alcohol or acids. The same reagent reveals a similar envelope on the *Oscillariæ*, and I believe the motion to be the same in the two forms of protophytes. In fact, if a diatom was a long elastic rod, it would merely vibrate, for I have observed that the motion is generally in opposite directions on the two valves; but the diatom can only move by creeping along a surface, hence its motion

* Amer. Mon. Micr. Journ., iv. (1883) pp. 61–2.

is only affected by the direction of the motion of the gelatine on one valve—the one that comes in contact with a surface. The motion is only on the sides, or valves. If a frustule is turned with its so-called front view up, it cannot move, at least those under my investigation did not, unless one of the valves comes in contact with some body of greater weight than itself, if we may so put it; for small particles will move along the valves, while the diatom remains stationary. The ribs have much to do with this power to creep, for the pallium is folded to the ribs, and being striated lengthwise it is plain to see how the pallium covers the valves with thousands of little feet. There is great room here for investigation with the recent very wide-angled glasses, but let me here give common glasses their due, for all that I have discovered has been done with only such."

Pfitzer's Diatomaceæ.*—In his account of the Diatomaceæ contributed to Schenk's 'Encyklopaedie der Naturwissenschaften,' E. Pfitzer commences with the simplest types, such as *Pinnularia*, proceeding then to the complicated structure of some marine algæ. With regard to their power of spontaneous motion, he adopts Schulze's view that it is due to extensions of the protoplasm which protrude through fissures in the cell-wall, although these have not yet been actually detected; rejecting that of Mereschkowski, that it is the result of an osmotic process. The jerks and vibrations described by this latter writer as observable in bacteria which are located close to the suture of diatoms, Pfitzer states are in no way due to motile processes. The ordinary mode of fission is then described, as well as the formation of auxospores. As regards their systematic position, Pfitzer regards the diatoms as most nearly allied to the Schizophytæ rather than to the Conjugatæ.

MICROSCOPY.

a. Instruments, Accessories, &c.

Bertrand's Petrological Microscope.†—This instrument (fig. 60) is designed by M. Bertrand, the Director of the 'Comptoir Mineralogique,' at Paris, and has several specialities :—

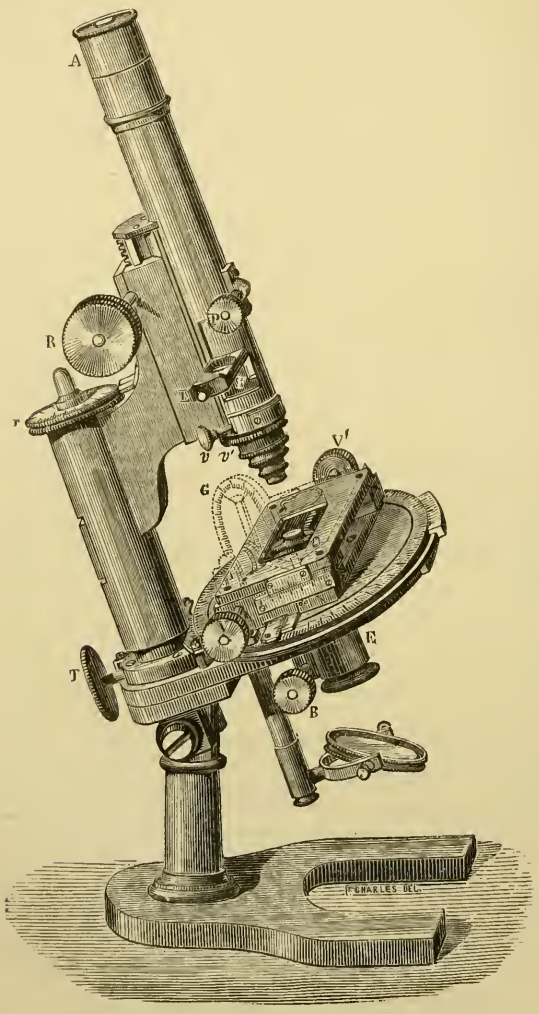
Above the objective at F is inserted a slide L with an achromatic lens so as to use either parallel or convergent light as may be desired, the slide being raised or lowered by a rack-and-pinion movement, the milled head of which is shown at P. A slow motion is given to the rotating plate of the stage by a tangent screw terminating in the

* Pfitzer, E., 'Die Bacillariaceen' (Diatomaceæ).

† Trutat's 'Traité élémentaire du Microscope,' 1883, pp. 266–70 and 300–1 (3 figs.). In addition to the references given in the text, A is the eye-piece, R the milled head of the coarse adjustment, *v v'* the centering screws for the objective, V V' the milled heads of the stage movements, and B that of the substage tube, E, for the polarizer. At F can be inserted a mica quartz-plate or a quartz prism.

milled head T. This screw works in a clamp which can be screwed to the stage, and when tightened up the rotation of T causes the clamp, and with it the stage, to revolve. When the clamp is

Fig. 60.



loosened the stage can be revolved by the hand. This mechanism effecting the slow rotatory motion of the stage is similar to that generally applied in the construction of theodolites and alt-azimuth instruments.

The body-tube is graduated and the focal distance is read by means of a vernier on the limb; the milled head of the fine adjustment r is divided; the rectangular movements of the mechanical stage are also each provided with a scale and vernier, while the margin of the stage is graduated and has two fixed verniers.

There is a spring clip for rapidly attaching the objectives.

A special form of goniometer (figs. 61 and 62) is adapted to the stage, for measuring the distance apart of the optic axes in air or in oil or other liquids. The object is held in forceps attached to a

Fig. 61.

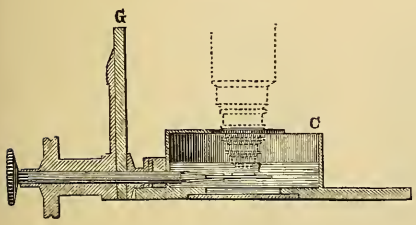
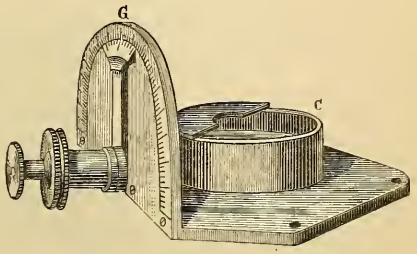


Fig. 62.



spindle connected with the smaller of the two milled heads. This rotates independently for adjusting the object or can be withdrawn if required. When the adjustment has been made the rotation of the larger milled head, to which a vernier index is attached, carries with it the inner spindle and forceps, and the extent of the inclination thus given to the object is measured by the index on the graduated semicircle G. The circular box C holds the liquid, and has an aperture at the bottom closed with a glass plate admitting light from the mirror.

Fase's Portable Binocular Dissecting and Mounting Microscope.*—The Rev. H. J. Fase describes an arrangement by which all the things required for dissecting and mounting, as well as a binocular for observing, can be carried in a compact form, and comprising:—

I. A full-sized, steady dissecting stage, with sloping rests for the hands. Two pairs scissors, knives, two pairs forceps, watch-glass, needle-points, &c.

II. An arm so constructed that it will carry a large low-power lens for dissecting. A ring, into which various objectives can be dropped for the same purpose, and a binocular body, which can be easily substituted for the ring, and allows of the manner in which the dissection is progressing to be inspected, and also steady enough to make an efficient binocular for ordinary observation.

III. Places in the case for a small number of cements, and media most usually required by working microscopists. Brushes, dipping tubes, lamp clips, slides, glass circles, troughs, a hot plate, and turn-

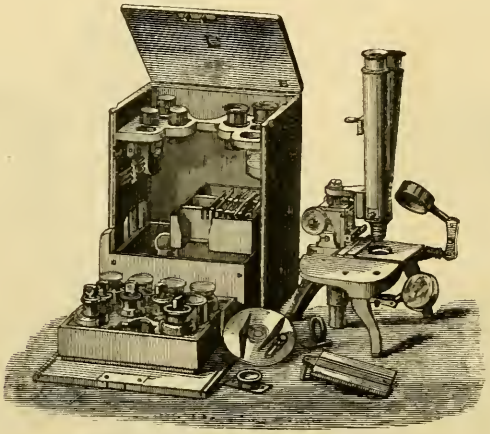
* Journ. Quek. Micr. Club, i. (1883) pp. 109–11.

table, packed in such a way that each of them should be safely carried, easily got at and replaced, every fitting being full-sized.

In fig. 63 the Microscope is shown on the right, with the binocular tube and condensing lens in place. Beneath is the ring for the objectives, which replaces the tube when a compound Microscope is not required. The turntable and hot stage are shown separately. The three trays contain the various reagents, cements, &c. The objectives are at the top of the case.

In packing, the small tray seen inside the case is dropped into the large bottom tray. The second large tray (in front) is placed on

Fig. 63.



the first, and the Microscope without the tube stands over both, the legs fitting into places in the trays. The binocular tube lies horizontally parallel to the back of the case. The front and top of the case opens as shown in the fig.

Mr. Fase calls attention to one or two points which he thinks might escape notice on a first inspection :—

The condenser is formed of two lenses, and besides acting as an ordinary condenser, makes a capital long focus dissecting lens. The mirror is removable, and can be utilized as a side reflector above the stage. The achromatic condenser, fitted with stops, giving a good black-ground effect, works by a milled head *above* the stage, and conveniently near the other adjustments. The rest for the hands while dissecting,, which the stand gives, is equally available when the binocular is being used for general observation. It is comfortable, and will be found to increase delicacy in the manipulation of objects.

Though rigid, the stand can be made lighter than can that of the ordinary form. The whole apparatus will not be more weighty than an ordinary binocular instrument; while it will, with all the helps to dissection, mounting, and observation, pack in a space not larger than

ordinary small monocular instruments, viz. 9 in. × 5 in. × 5 in. A larger number of cements could be carried if the bottles were of a slightly smaller size, and it is proposed that, instead of the outside case being of polished mahogany, it should be of painted canvas, such as portmanteaus are made of.

Whilst specially constructed for travelling, the instrument may be useful to workers, as comprising in a small compass many things necessary for microscopical work.

Klönne and Müller's and Seibert's Demonstration Microscopes.—In Klönne and Müller's instrument (fig. 64) the body-tube, with the eye-piece and objective, slides (for coarse focussing) in an outer tube, and can be secured in any position by the screw acting on a split ring at the upper end of the outer tube. At its lower end the latter tube is screwed to a plate about 3 in. square with four supports at the corners, on which the instrument rests when it is not in use. Beneath this plate is a second one, which is attached to the former at one side only, and is movable on a hinge joint. Two springs between the plates pull them together, and a screw (shown above the upper plate) forces them apart when desired and forms the fine focussing movement.

Fig. 64.

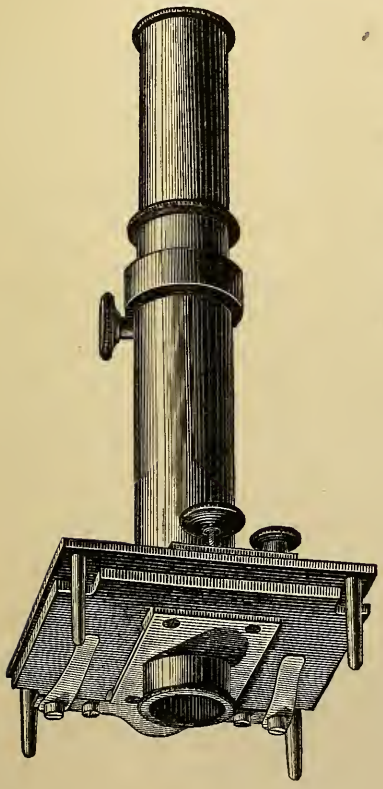


Fig. 65.

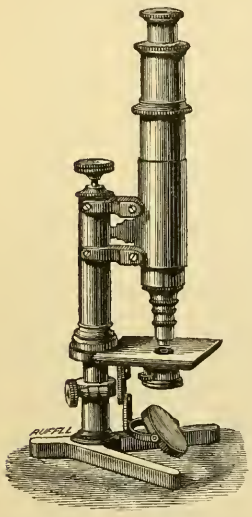
The slide is placed beneath the lower plate, and is held in position by two spring clips.

A condensing lens slides into the short tube attached to the small plate shown at the bottom of the figure, the plate being supported on two side-pieces to keep it clear of the slide.

Seibert also supplies the Microscope shown in fig. 65, the construction of which, as will be seen, is very similar to that of Klönne and Müller.

Seibert's Travelling Microscope. — This instrument (fig. 66) is reduced in height (within a range of an inch) for packing, by making the standard which carries the body-tube and stage, slide in a socket attached to the tripod base. A clamp screw tightening a ring on the socket allows the standard to be secured at any given point.

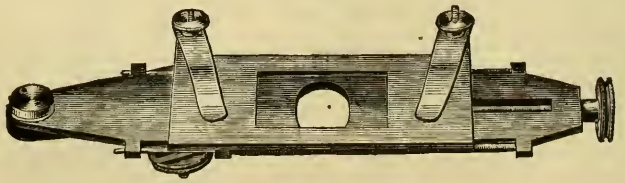
Fig. 66.



Klönne and Müller's "Pendulum Stage." *— This (fig. 67) is another form of mechanical stage (of German construction) intended to be attached to the ordinary stage of a Microscope (as shown in fig. 68) when it is desired to examine flesh infected with *Trichinæ*, or other objects which require a systematic examination of the whole surface.

It consists of three plates, the lowest being connected with the middle one by a pivot "like that used for the hands of a clock." By means of a clamping arrangement attached to the lowest plate, the apparatus can be fixed to the stage, care being taken that the circular aperture in the middle plate is centered with the axis of the microscope-tube. The upper plate has a square aperture, and carries the object. It slides on the middle plate by a screw (the milled head of which is seen on the right). The move-

Fig. 67.

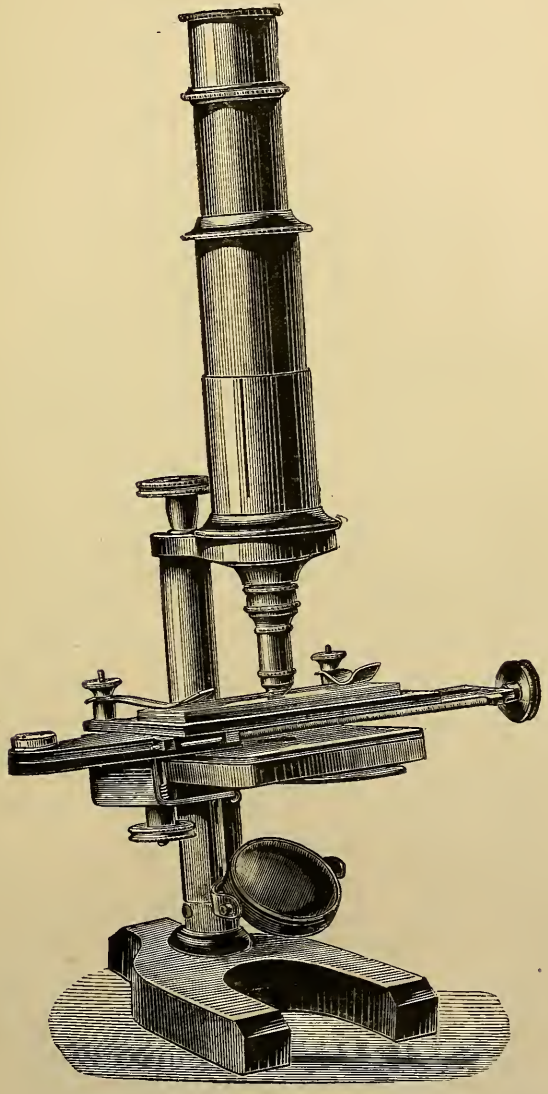


ment is regulated by two spiral springs. The object being in the field, the two upper plates are moved slowly from front to back, or

* See Centr. Ztg. f. Opt. u. Mech., ii. (1881) p. 113 (1 fig.).

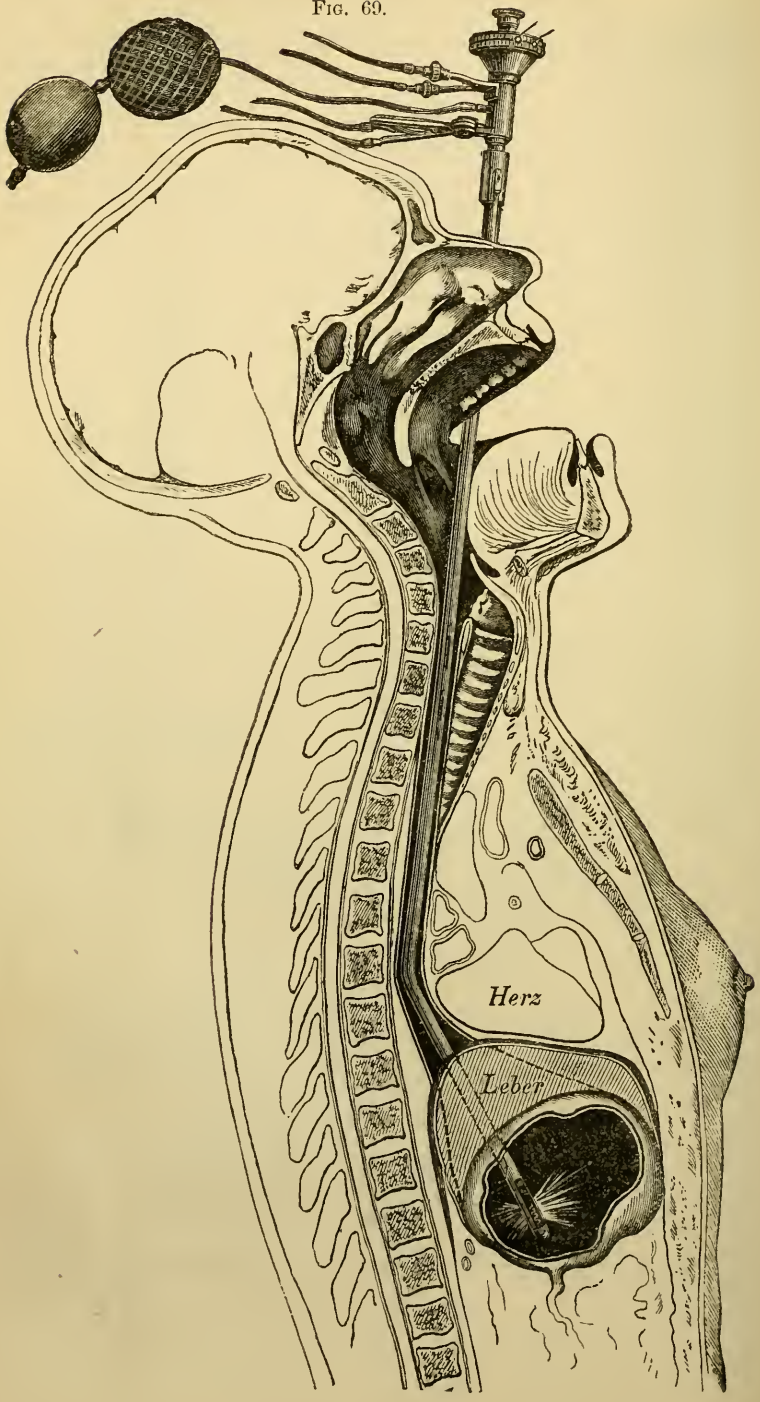
vice versâ, on the pivot (i. e. like a pendulum, whence the name). It is then shifted slightly by the screw on the right, and the pendulum

FIG. 68.



movement repeated, and so on until the whole of the object has passed under observation.

Fig. 69.



Leiter and Mikulicz's Gastroscopes. — J. Leiter * has devised a great variety of instruments intended for inspecting various more or less inaccessible parts of the body, including the mouth, larynx, œsophagus, stomach, intestines, urethra, bladder, vagina, rectum, ear, nasal fossæ, &c. They all agree in providing for the introduction of a small electric light into the cavity to be examined, with a special provision for preventing any inconvenience from heat by the circulation of a stream of water—a plan originally suggested by Dr. Bruck.

Most of the instruments also provide for the introduction of an objective, which forms an image of the part examined, the image being received by an eye-piece either direct or, where necessary, after being diverted in the proper direction through prisms.

Leiter's original gastroscope in particular was a marvel of ingenuity in the various arrangements for allowing the walls of the stomach to be illuminated and examined by the aid of lenses, but has apparently been found too complicated for practical use, and a simplified form is described by Dr. J. Mikulicz † (with a great elaboration of detail on all points), which has been devised by him in collaboration with Herr Leiter.

The tube A (fig. 70) is 65 cm. long and 14 mm. thick, and is bent at F at an angle of 150°. At B is the platinum wire for the electric light covered with a glass plate and connected, by wires running up the tube, with the key C and a Bunsen battery. Two water-tubes also run up the main tube, their ends being shown at D, a constant stream of water being maintained during the observation so as to prevent the lower end of the tube becoming heated. There is an additional tube for pumping water into

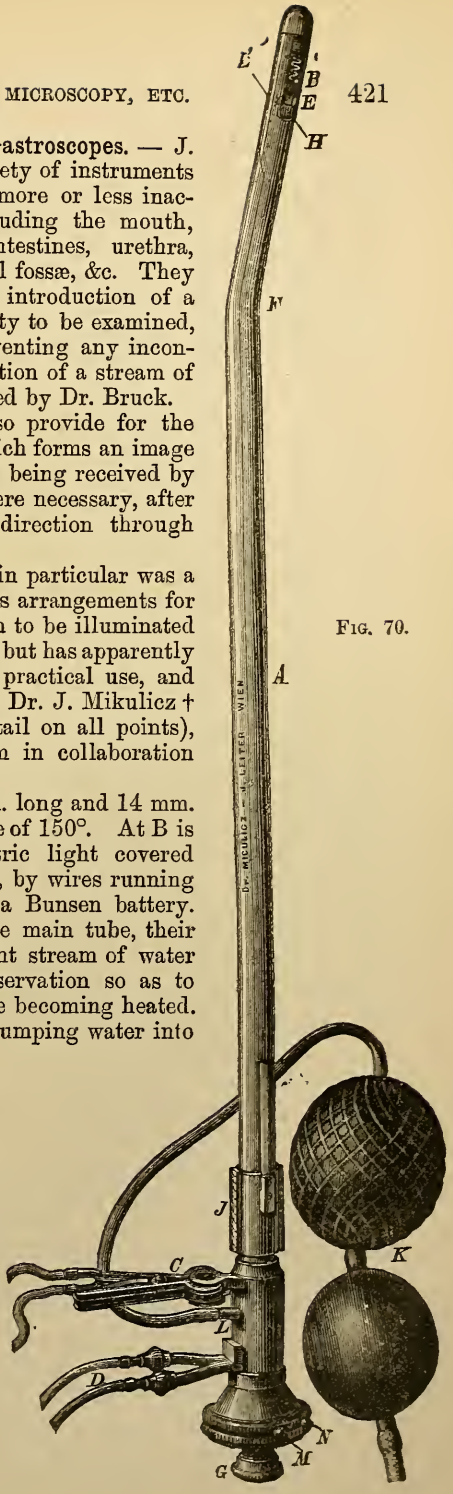


Fig. 70.

* Leiter, J., 'Elektro-Endoskopische Instrumente. Beschreibung und Instruction zur Handhabung der von Dr. M. Nitze und J. Leiter construirten Instrumente und Apparate zur direkten Beleuchtung menschlicher Körperhöhlen durch elektrisches Glühlicht.' 65 pp. and 82 figs., 4to, Wien, 1880. Cf. also Engl. Mech., xxxiii. (1881) pp. 27–8 (9 figs.).

† Mikulicz, J., 'Ueber Gastroskopie und Oesophagoskopie.' (Sep. Repr. from 'Wiener Medizinischen Presse,' 1881.) 32 pp. (3 figs.) 8vo, Wien, 1881.

the stomach, which commencing at the indiarubber balls K passes into the main tube at L and is continued to L′ where there is a small aperture.

The optical apparatus consists of a prism and an objective at E (the prism being right-angled and acting as a reflector to transmit the rays from the side of the instrument up the tube), a second prism at the bend at F, and an eye-piece at G. To prevent the glass plate at B from being smeared whilst the instrument is passed down the œsophagus a metal shutter H slides over it and can be drawn back by moving the collar at J.

The fact is enforced in italics that the instrument can be introduced into the bottom of the stomach without difficulty, and fig. 69 is given in illustration of the statement; another figure showing the advantage of the bent end in allowing different parts to be illuminated and observed by simply rotating the tube, the stomach being distended to facilitate the excursions of the tube. The author's pamphlet contains not only a very full description of the instrument, but minute directions for its use.

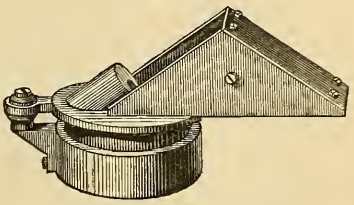
Dr. T. Oliver describes * a successful experiment of examining the interior of a patient's liver by one of the small Swan incandescent lamps described by Mr. Stearn *ante*, p. 29. The apparatus used was an electro-plated brass tube 9½ in. by 11-16ths in., closed at the lower end by glass, down which was inserted a narrow cylinder carrying a lamp and wires. Mr. J. B. Payne (a Fellow of this Society), who devised the arrangement, considers it to be much simpler than Leiter's platinum wire as it gives a perfectly pure light and developes less heat. He says "a Swan's electric lamp is used—the filament of which is carbon, and rendered incandescent by means of battery power. It is hermetically sealed in a glass shade; and water, conveyed to and fro through very small brass tubes, is made to circulate round the lamp. The light from this lamp is perfectly pure, and exhibits the condition of things in their true and natural colour. For prolonged observation I should prefer to use either a Grove's or Bunsen's battery, but in the demonstration just referred to, four cells of a modified Leclanché battery were employed and answered admirably. It is advisable to have as great a pressure as possible for the water supply, so as to insure perfect circulation, and for this I suspended from a hook fixed near the ceiling of the room a tin can containing water, connecting it with the brass tubes by means of lengths of indiarubber tubing."

Cobweb Micrometers.†—Mr. G. F. Dowdeswell prefers a cobweb micrometer which has the second web movable instead of being fixed as in the usual form. This both saves time and promotes accuracy, as when only one web is movable it is almost impossible, by means of the mechanical stage, to bring an object into exact contact with the fixed web, which is done at once with ease and certainty by the second movable one.

* Brit. Med. Journ., 1883, Jan. 27.
† Quart. Journ. Micr. Sci., xxiii. (1883) p. 337.

Chevalier's Camera Lucida.—Dr. Carpenter describes * a form of this camera intended to be used with the horizontal Microscope. Fig. 71 shows a modification designed by Dr. A. Chevalier † for a vertical Microscope. The reflecting prism is made much larger and is brought close to the small perforated metal speculum. The whole field is readily seen without any part being obstructed.

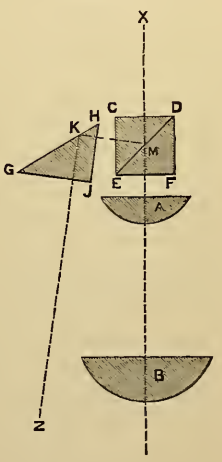
Fig. 71.



Grunow's Camera Lucida.—This camera (*ante*, p. 120) was the subject of discussion at the May meeting of the Society, and for convenience of reference we add fig. 72, showing its construction.

A and B are the lenses of the eye-piece; D C E, D F E, and G H J three right-angled prisms, the first two having their hypothenuses cemented together with balsam to make a cube. Prior to cementing, the upper of the two prisms has its hypothenuse silvered, but a small spot, not more than 1-16th in. in diameter, is afterwards denuded of silver as nearly as may be in the geometrical centre of the silvered face at M. The prism G H J is movable on an axis, to provide for its use when the instrument is either upright or inclined. Rays from Z, the table, are totally reflected from the face G H (say at K), and entering the upper prism, are reflected to the eye at X by the silvered surface D E, while the object is seen at the same time through the unsilvered spot in the middle of the same face.

Fig. 72.



A writer in the 'English Mechanic' ‡ says that it is not a *sine quâ non* to silver the surface, but the effect is wonderfully improved by doing so, the blue tint that otherwise appears to cover the object being almost entirely eliminated by the white reflection from the silver; and that this form of apparatus can be used with less straining and eye-fatigue than any he ever tried.

Holle's Drawing Apparatus.§—The device of Dr. H. G. Holle differs essentially from all other forms of drawing apparatus, and was

* 'The Microscope and its Revelations,' 6th ed., 1881, p. 114 (1 fig.).
† 'L'Étudiant micrographe,' 3rd ed., 1882, pp. 167–8 (1 fig.).
‡ Engl. Mech., xxxvii. (1883) p. 154 (1 fig.).
§ Nachr. K. Gesell. Wiss. Göttingen, 1876, pp. 25–7. Cf. Behrens' 'Hilfsbuch z. Ausfuhrung mikr. Untersuch. im bot. Laborat.,' 1883, pp. 90–1.

suggested with the view of obviating the difficulties found with the ordinary forms in regard to the eye and hand having to be placed in very inconvenient positions.

The principle of its construction is that neither the pencil itself nor its reflected image is seen, but an image of it formed by convex lenses. With this object the eye-piece of the Microscope in its ordinary position serves at the same time as the eye-piece of a telescope, whose axis is twice bent at a right angle. This is provided with two mirrors, the first of which (0·2 mm. thick, and necessarily transparent) is immediately beneath the eye-piece, and the second (which need not be so thin) is over the objective of the telescope. Between the two mirrors is a lens which again erects the inverted image of the pencil.

By the use of this apparatus the microscopical image is seen direct and without any fatigue to the eye. The drawing hand also lies on the right directly beneath the Microscope and therefore in the most convenient position.

To avoid the glare of the paper drowning the image of the object, Dr. Holle recommends—not the more simple process of modifying the light—but that the drawing should be made with a white pencil on a black ground. "In order, however, not to copy what has been already drawn, it is best to take black unglazed paper, blacken it on the reverse side with lead pencil, and lay it on the drawing paper. The marks of a pointed piece of bone can be seen on the unglazed black paper with sufficient clearness to know which lines of the image already exist on the drawing paper and which not."

Manipulation of the Beck Vertical Illuminator.* — Dr. J. Edwards Smith considers that this illuminator is a difficult one for the tyro to use, and that his first attempts will probably result in failure, and whilst it is not easy to give the necessary instruction in writing a few hints may prove of value.

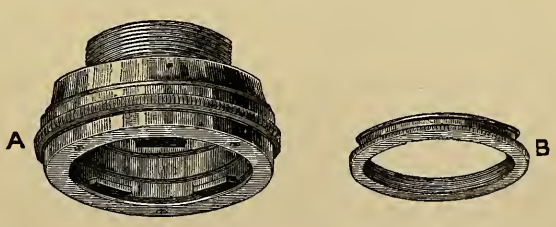
A dry mount of *Podura* answers very well for the novice to work upon. Select the widest aperture objective, and examine the object in the ordinary way and get a tolerable correction. Next put on the illuminator, and using transmitted light "hunt through the slide; among the numerous scales will probably be found one or two which, in order to bring into focus, the objective will require to be withdrawn from the cover slightly. In such a case the chances are that that particular scale is nearer the cover, and if in good condition may be selected for further operations. Next, bring the lamp (a flat-wicked one) towards the observer, revolving the tube of the illuminator so that the lateral aperture shall be in proper position to receive the light from the lamp, the latter being about seven or eight inches distant, and the flame about the same height as the aperture of the illuminator. Now grasp the little knob connected with the interior glass disk and turn it so that light shall be reflected to the rear of the objective; at the same time, and looking through the tube as you

* 'How to see with the Microscope,' 1880, pp. 221–3.

catch the first glimpse of light, revolve simultaneously the main tube and also the little knob carrying the glass disk, the object being to secure as great an amount of light as possible. A little manipulation of this kind ought to result in illuminating the object with a horizontal (or nearly so) band of light. The next step will be by a slight movement of the lamp, keeping its edge *exactly* towards the aperture, to endeavour to make the band of light crossing the field as *narrow* as possible, and the outlines of the band clear and distinct. By this time the operator will have probably discovered that a slight rotation of the main tube will separate the horizontal band into two parts, or, as some of my pupils express it, 'two tongues.' The best position is when these are made to coalesce as completely as possible. It is also probable that in the attempts thus far made the image of the scale has been well seen. When this occurs it should be at once focussed. The next procedure is to correct the objective; the correction obtained by transmitted light will not suffice for the purpose in hand. It will be noticed that as the glass is made to approach the correct adjustment, the horizontal band of light will be correspondingly improved. So true is this, that one might almost be governed thereby in the adjustment of the object. Having got thus far along, and without any serious mishap, it will be easy, by closing the shutter, to admit the precise and most favourable amount of light, and also to try the effect of sundry *very slight* changes in the position of the main tube, glass disk and lamp. Very beautiful resolutions are sometimes obtained by bringing the lamp within five or six inches and interposing the bull's-eye condenser, flat side to the lamp, in which case the shutter must be further closed. It will happen also, occasionally, that the best exhibition of striæ on very difficult objects, such as extremely close *Frustulia saxonica*, is when the striæ are placed at right angles to the horizontal band of light."

Pease's "Facility" Nose-piece.—This appliance (fig. 73) has been devised to facilitate the rapid interchange of objectives. The

Fig. 73.



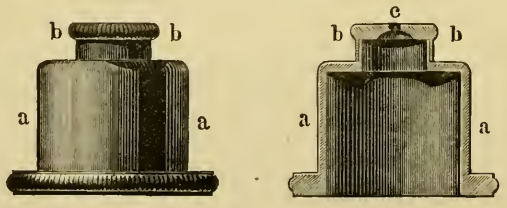
adapter nose-piece A screws on to the nose-piece of the Microscope by the usual "Society" screw, where it may remain permanently. It is provided with mechanism similar to that applied in the "self-centering" chuck. By the partial rotation of the milled collar three

sections of a flat spiral are made to act upon three sprung steel teeth, causing them to project from slots within the cylinder, or to return to their normal positions at will. B is a small ring with which each objective must be provided; it screws on the objective, where it may remain, and on its outer edge is a flanged groove. The objective, having the ring B attached, can then be slid into the "Facility" nosepiece, when about one-tenth of a turn of the milled collar on the latter causes the teeth to grip in the flanged groove of B, thus securing the objective in place; the reverse movement releases the teeth from the flanged groove, when the objective will drop into the hand.

As a piece of mechanism this device is ingenious. It appears to us, however, that with high powers unsteadiness and defects of centering will prevail to such an extent as to be fatal to its general adoption.

German "Cylinder-Diaphragms" and Condensers.—It is very much to be desired that the old wheel of diaphragms so distinctive of English instruments should be done away with, even with the smaller stands. To replace it no expensive apparatus is necessary, the "cylinder-diaphragm" of the German opticians serving all the purposes for which the "wheel" is used, and having the advantage of lying quite flush with the stage and exactly central, neither of which points can be secured with the old form. The contrivance consists simply of a tube *a*, *a*, fig. 74, having a narrow neck over which fit small caps *b*, *b* (the exact size of the opening in the stage) pierced with larger or smaller holes, *c*, as desired.

Fig. 74.



The usual condenser of the German instruments is also a very simple and convenient apparatus for the smaller stands. It consists only of a plano-convex lens *l* (fig. 75) in a fitting (*a*, *a*) nearly identical with that of the cylinder-diaphragm holder.

W. Behrens * considers the contrivance shown in fig. 76 *a*, *a*, with three small movable disks, as convenient for use in combination with these condensers for stopping off the central rays.

For attaching the fitting of the cylinder-diaphragms to the stage (as also the condenser) the slide *e e*, fig. 77, is useful and renders unnecessary any alteration of the mirror, as is the case when the dia-

* 'Hilfsbuch z. Ausführung mikr. Untersuch. im. bot. Laborat.,' 1883, p. 69.

phragms fit into a fixed tubing below the stage. The diaphragm-tube slides in *f*, and the milled heads *d* serve to remove the plate when it is

Fig. 75.

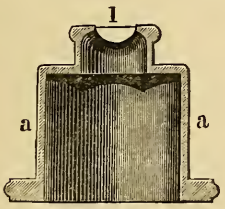
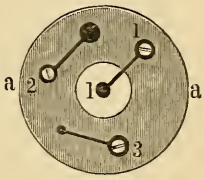
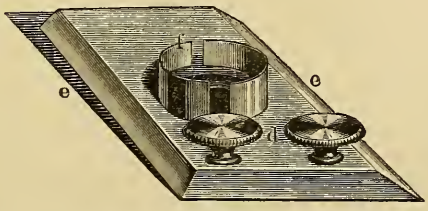


Fig. 76.



required to change the diaphragms. In some cases centering arrangements have been adapted. M. Nachet uses, in place of a sliding plate,

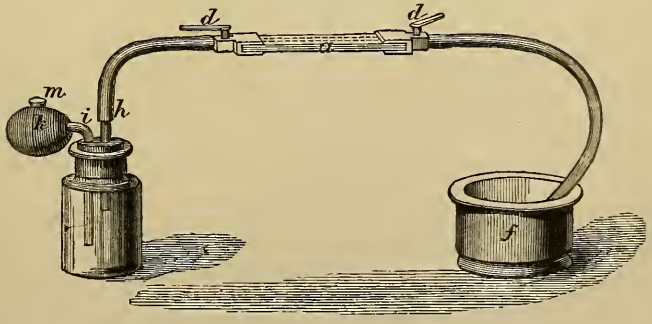
Fig. 77.



a movable arm which swings away from the stage in changing the diaphragms.

Pinkernelle's Apparatus for the Examination of Fluids.*— W. Pinkernelle's apparatus is shown in fig. 78. It consists essen-

Fig. 78.



tially of a glass plate *a*, in which is a channel closed at both ends by taps *d*, and having two indiarubber pipes, of which one dips into a

* Specification of German Patent, 1881, No. 18,071, and explanations issued by the author.

vessel *f* containing the fluid under examination, and the other communicates with a glass tube *h* leading into a bottle. There is a second tube *i* with an indiarubber ball *k*, having an orifice *m* at its upper end. The glass plate is laid on the stage of the Microscope, and the opening in the ball closed with the forefinger; the ball being first pressed between the middle finger and thumb of the left hand, and then relaxed, the fluid will be drawn from the vessel *f* into the bottle.

When the taps are completely open, the fluid flows so quickly that the particles which it contains are not seen, but by more or less closing one of the taps, they either pass slowly across the field, or (by quickly shutting them in the field) they can be retained for closer inspection. Pressure on the indiarubber ball will also cleanse the apparatus with water after using it. The channel is from 0·2 mm. to 1 mm. in depth.

The designer adds that the "apparatus is also suitable for drawing-room use, when say a binocular Microscope is exhibited for the amusement of spectators. The apparatus can be easily adjusted so as to pass a whole microscopic aquarium over the field of view." It can also be connected with a hand Microscope constructed for it, which when used is held towards the light, and in this way is useful on excursions. The vessel which holds the fluid must, however, be provided with a fine sieve, the meshes of which must correspond with the size of the channel. The material—mud, sand, chalk, clay, &c.—is rubbed over the sieve, and a little water poured on so that the finer parts may be washed through. It can also be used as a moist chamber, in order to observe the development of the various infusoria, diatomaceæ, bacteria, &c.

Moist Chamber.*—Mr. R. Hitchcock finds the following very convenient for cultivations:—

A piece of glass, 4 in. square, is placed upon a support so that it is about on a level with the top of a dish to hold water—an ice-cream saucer is what he used. A piece of blotting-paper is then placed on the glass, and the edge allowed to dip into the water. Objects to be examined are placed on large cover-glasses, and either covered with a small cover, or left exposed. These cover-glasses are laid upon the blotting-paper and covered with watch-glasses. A single large watch-glass of 3½ in. diameter may be used, or a number of small ones, one for each specimen. Objects can be kept fresh and moist in this way, with far less trouble than by any other method he has tried.

Hartnack and Prazmowski's Polarizing Prism.†—It is surprising that this prism is not to be found in England, when it presents such advantages over the old form of Nicol prism. As this may be due to the fact that the description of it has not hitherto appeared in English, we subjoin a translation of the original article by its designers:—

"The Nicol prism possesses valuable qualities which unquestion-

* Amer. Mon. Micr. Journ., iv. (1883) pp. 56–7.

† Annales de Chimie et de Physique, vii. (1866) pp. 181–9.

ably make it the best of known polarizing instruments, whether employed as an analyser or as a polarizer. Being constructed of a perfectly colourless substance, it transmits the light without altering the colour or dispersing the rays, and also without sensible diminution by the two partial reflections at the surfaces of entrance and exit.

A careful investigation of the course of the rays in this apparatus shows, however, some rather considerable defects, arising primarily from the direction in which the crystal is ordinarily cut, and also from the nature of the medium hitherto employed to reunite the two parts.

As is well known, the Nicol prism is simply a parallelopiped of Iceland spar, the length of which is equal to 3·7 times its thickness (fig. 79), and which is cut in two along the diagonal A B which joins the obtuse angles. The planes of section are carefully polished, and then cemented together with Canada balsam, the index of refraction of which (1·549) is intermediate between the *ordinary* index of the spar (1·658) and the minimum of its *extraordinary* index (1·483).

The limiting angle for the ordinary ray on the film of Canada balsam being 69° 5′, every ordinary refracted ray which is incident at a more oblique angle undergoes total reflection.

If, for instance, the ray *o d* enters obliquely at the face A C, it will undergo at *d* a refraction which causes it to take the direction *d f*. If it forms with the plane A B an angle of 20° 5′, this ray will limit the field from which ordinary rays are excluded, since all such rays arriving on the film of balsam at a greater angle would undergo total reflection. Thus all the rays comprised between the extreme directions *o d* and *e* A, ordinarily refracted in the spar, will be reflected at *f*, and will form a luminous cone *h f g*, which will be lost on the blackened face C B. The extraordinary rays, on the contrary, their index being lower than that of balsam, will traverse the latter, and will spread out at their exit into the space *i k*. It is not, however, the plane of the section which limits the field on the side A *e*. The extraordinary ray, in proportion as it approaches this plane, makes, with the principal axis of the spar, larger and larger angles; its index diminishes, it is true, but never reaches a value so small as to traverse under all angles of incidence the film of balsam. Under sufficiently large angles it undergoes in its turn total reflection. This is the other limit of the field of the prism. The inequality of the dispersive power of the balsam and of the spar reduces still more this limit, and renders the field still smaller.

As the index of the Canada balsam is very little inferior to that of the spar for the ordinary ray, and the limiting angle for this ray is 69° 5′, it is necessary to make the prism of considerable length—equal, as mentioned above, to 3·7 times the small side. The total length of the prism is represented by the projection of the long diagonal on the axis of the prism, i. e. four times the length of the small side.

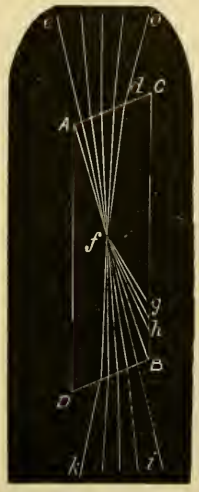
To obviate these inconveniences it has been proposed to employ different cementing substances, and particularly balsam of copaiba, the index of refraction of which is lower, which would allow of the prism being shortened. But the prism was still always cut

in the same direction, so that the extraordinary rays underwent total reflection long before reaching the plane of section, and if the field gained in extent on the side of the ordinary rays, it lost much more on the side of the extraordinary rays. In fact the field was reduced.

From this it will be seen that, so long as the direction of the plane of section relatively to the axis of the crystal remains the same, it would be useless to resort to any other cementing substance than balsam. Before insisting further on the effect of the direction of section, it is desirable to consider the result of the obliquity of the faces of incidence and emergence of the prism relatively to its axis, and to the direction of the luminous rays which traverse it.

Fig. 79 shows that the rays which pass from air into the spar on the side of the limit of the field A, traverse the face A C nearly normally, and that in proportion as they approach the other limit they incline more and more to the face of entrance; the same phenomenon being produced identically on the emergence of the rays

Fig. 79.



Path of the ordinary and extraordinary rays in a Nicol prism.

Fig. 80.

Path of the rays with different cementing media. C O A limit of the field for Canada balsam, K O A for balsam of copaiba, I O A for linseed oil, P O P' for poppy oil; *mm.* direction of the axis of the crystal.

at the opposite face. This progressive increase of the obliquity of the incident rays produces an increasing partial reflection and a proportionate diminution of the transmitted light; so that the field whilst very luminous on one side becomes darker and darker towards the other.

This obliquity of the faces of incidence and emergence gives rise

to a still greater inconvenience. Iceland spar is very soft, and the optician has much difficulty in producing true surfaces with it. The polishing always deforms the surfaces notwithstanding all the care and skill of the workman; and the slight deviations which cannot be avoided in the surfaces affect the direction of the transmitted rays the more injuriously, according as the angles of incidence are large.

In fact, whenever the rays form after their passage through the prism a real or virtual image, this image is always confused and badly defined. But it is especially when the image has to be again amplified that the defects in the surfaces give rise to the most troublesome consequences.

These considerations led the authors to think that the first thing to be done by way of remedy was to give to the faces of incidence and emergence, a direction normal to the axis of the prism. This direction allows the rays which traverse the centre of the field to reach the eye of the observer without having undergone any deviation, and it reduces by half the angles of incidence of the rays which limit the field. Under these conditions the choice of a more suitable section and the application of a better cementing substance would suffice to give to the polarizing prism all the qualities desirable.

The lower the index of refraction of the cementing medium, the greater the limiting angle under which the ordinary ray is totally reflected, and the more the dimensions of the prism may be reduced. But if its index has a value less than the minimum of the extraordinary index, notwithstanding the best selection of the plane of section, it is this ray which in its turn will undergo in a part of the field total reflection, and which will be stopped. Hence, as in a prism of ordinary construction, a diminution in the angular extent of the field of vision. The most suitable cementing substance should be one whose index has the same value as the extraordinary index in the section perpendicular to the axis. Linseed oil, a substance sufficiently drying for this purpose, has an index (1·485) identical with that of the spar; it allows therefore of a length less than that which is necessary when Canada balsam is used, and gives at the same time the large field of 35°. Poppy oil, which has a lower index, allows of a still greater diminution in the length of a prism, but it at the same time reduces the field to 28°.

We are now able to consider the following questions:—

1st. What is the direction which should be given to the plane of section to obtain the most advantageous size of field?

2nd. What inclination should be given to the faces of incidence and emergence relatively to this plane in order to insure the condition of normal incidence on these faces to the rays which correspond to the centre of the field?

To reply to these questions it is desirable to consider the path of the rays in the interior of the prism. Divide a parallelopiped of spar in two parts by the plane A B, fig. 80, perpendicularly to the principal axis of the crystal. The lines oblique to A B represent the limiting angles of the ordinary ray for the following substances by means of which the two halves may be cemented together.

	Index.	Limiting Angle.
Canada balsam	1·549 ..	69° 1′
Balsam of copaiba	1·507 ..	65° 3′
Linseed oil	1·485 ..	63° 6′
Poppy oil	1·463 ..	61° 9′

For the first three substances, even the extraordinary ray which grazes the surface A B does not undergo reflection. The plane A B forms the other limit of the field. It is not the same for poppy oil: the extraordinary ray is reflected at an incidence of 79° 9′ represented by the dotted line O P′.

In the *interior of the spar* the extent of the field with these different substances is as follows:

Canada balsam	20° 9′
Balsam of copaiba	24° 7′
Linseed oil	26° 4′
Poppy oil	17° 0′

The position of the faces of incidence and emergence must be such that the rays which limit the field on the two sides are equally inclined to these faces so as to give a field symmetrically disposed relatively to the axis of the prism. As on one side the limiting ray is refracted according to the ordinary index, whilst on the other side it is refracted according to the extraordinary index, the faces of incidence and emergence cannot be perpendicular to the line which divides in two the field in the interior of the prism. These faces should have a less inclination on the side of the ordinary ray than on the other.

In the calculation of this inclination there is a consideration which must not be omitted: it is that the dispersive power of spar for the extraordinary ray is higher than that of the fatty oils, and that their relative indices diminish in passing from red to violet. At about the limit of the field the blue and violet rays will still traverse the film of oil, whilst the red are arrested. The field is terminated on this side by a somewhat broad violet band which darkens it to a certain extent. It is, therefore, necessary to arrange to have on this side a larger portion of the field so as to employ only the part which is the most uniformly illuminated.

In consequence of this the following angles have been adopted, the crystal being supposed to be cut perpendicularly to the principal axis

	Angles of the faces of incidence and emergence with the plane of the section.	Angular extent of the field.	Length of the prism.
	° ′	°	mm.
Canada	79 0	33	52
Copaiba	76 5	35	37
Linseed	73 5	35	34
Poppy	71 0	28	30

of the spar, which assures, according to what we have above stated, the absolute maximum of angular extent of the field with cementing substances whose index very nearly approaches the extraordinary index of the spar in the plane normal to the crystalline axis.

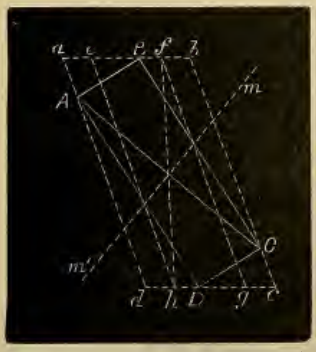
It must not be forgotten that the figure of the new prism is that which is really adopted in our instruments. Although the length of the longest side of the Nicol prism is only 3·7 (that of the smallest being taken as unity), the acute angles of this prism give it a length which is four times that of the small side.

Fig. 81 represents the new prism A B C D, with its section A C in a plane perpendicular to the axis of the crystal cut out of the parallelopiped *a b c d*. This construction requires a piece of spar larger than what is required in the Nicol prism. The same piece of spar, however, would only give a Nicol prism *e f g h* of nearly the same thickness as the new one but which would be more than a third longer than the latter, and that with a field of a third less in extent.

It is above all as an analyser that the new prism presents great advantages over the old form. It may, for instance, be placed very conveniently between the eye and the eye-piece of a Microscope without reducing the field of view; whilst the Nicol prism not only narrows directly the field in a notable proportion but also hinders the observer from approaching his eye sufficiently near to the point where the rays cross, an indispensable condition for embracing the whole field at one view."

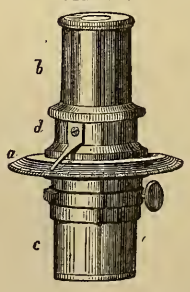
In Hartnack's analyser of recent construction (fig. 82) the mounting is united to the eye-piece *b c*, and there is a graduated disk *a*, in which the tube with the lenses and the analysing prism can be

Fig. 81.



Prazmowski (A B C D) and Nicol (*e f g h*) prisms. A C section of the crystal perpendicular to the axis *mm'*.

Fig. 82.



rotated. The pointer *d*, which rotates with the prism, indicates the angular magnitude of the revolution which has been made.

Leitz, and Seibert and Krafft have also constructed this apparatus of Hartnack's, adding a vernier and crossed wires; and Merz, Wasser-

lein, and Vérick have adopted the graduated disk. "There is no doubt," say Nägeli and Schwendener,* "that such contrivances are convenient for certain observations (for instance, on circular polarization); but in most cases it is, at any rate, more important, with crossed Nicols and immovable plates of selenite, to bring the object by means of a rotating plate to the different positions with regard to the planes of polarization of the Nicols, and thus be enabled to determine the angles."

Apparatus for Rotating Polarizing Objects.†— C. Nägeli and S. Schwendener recommend as "practical and fully satisfactory" the

Fig. 83.

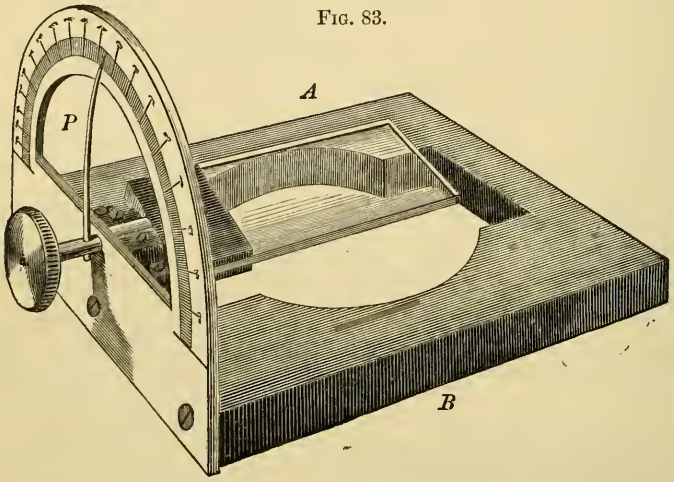
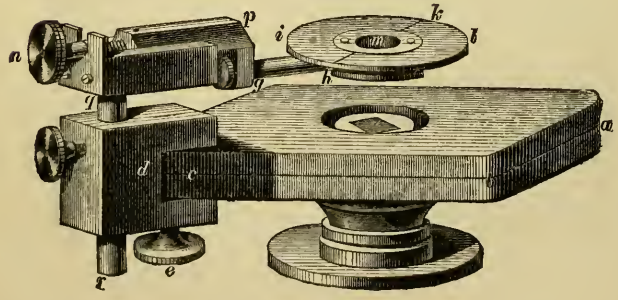


Fig. 84.



apparatus (to lie on the stage) shown in fig. 83, for obtaining rotation round a horizontal axis.

* 'Das Mikroskop,' 2nd ed. 1877, Engl. transl. (in the press), pp. 323-7.
† Ibid., pp. 326-7 (2 figs.)

To the brass plate A B, having a large central opening, is attached vertically a graduated semicircle, in the centre of curvature of which the pinion with a milled head is fitted in such a manner that it may be turned round an axis at right angles to the plane of the semicircle. This pinion carries on the other side of the semicircle two sprung brass plates, between which the glass slides are inserted. The slides are best applied so that an object lying upon them is adjusted to be in the axis of rotation, and consequently suffers little or no lateral displacement on rotation. The indicator P connected with the milled head, moves along the graduated scale, and thus gives the angle. It is advisable for certain purposes to arrange the apparatus so that the object can be turned under water or other liquid. This is the case, for instance, in the trough apparatus of Ebner,* which in other respects is constructed on the same principle as the author's.

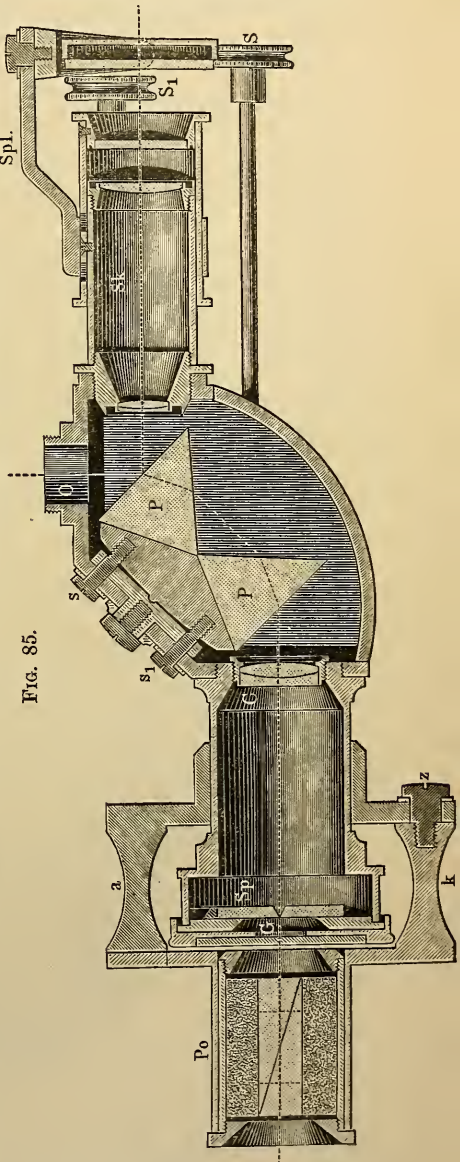


FIG. 85.

The same authors consider that Valentin's object-stage with double rotation (fig. 84) "does not answer satisfactorily the purposes required, as it affords no angular determinations: it may nevertheless be used in many cases. It is arranged for screwing to the ordinary stage, and is provided with adjusting screws for centering. The disk *h*, *i*, *k*, *l* can be revolved in its own plane, and likewise round the horizontal axis *g*.

Abbe's Spectro-polarizator. †—Dr. L. Dippel proposed to Prof. Abbe the construction of this piece of apparatus (fig. 85) in order, amongst other advantages, to obtain the benefit of Rollett's Spectro-polari-Micro-

* SB. K. K. Akad. Wiss. Wien, 1874. See also Bertrand's, *supra* p. 415.

† Bot. Centralbl., xii. (1882) pp. 284–6. L. Dippel, 'Das Mikroskop,' 2nd ed., 1882, pp. 620–2 (1 fig.).

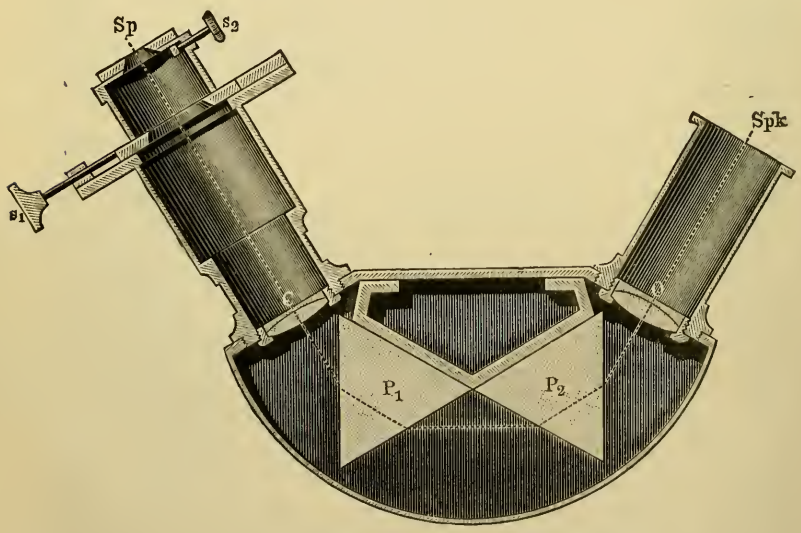
scope, without, however, being obliged to have a special Microscope for the purpose.

The apparatus is attached to the substage of the Microscope at O, lying parallel with the anterior side of the stage. The light passing through the slit Sp and the achromatic collimator C, is bent by the white flint prisms P P at an angle of 90°, so as to pass in the direction of the axis of the Microscope through an objective at O, which may be a low or high power as required. In front of the slit is a Prazmowski polarizing prism Po, which can be turned away on the frame a k z when ordinary light is required to be used. Selenites are introduced at G. The prisms give a much wider and better spectrum than a direct vision prism.

The arrangement on the right consists of an Angström scale, the image of which is projected by the lenses at Sk on the surface of one of the prisms P, and is thus reflected into the field of the Microscope in conjunction with the spectrum. As in the Zeiss Microspectroscope, the wave-lengths are given direct. The milled heads S and S_1 serve to move the apparatus from left to right, or from back to front, so as to obtain an exact adjustment of the spectrum, the proper focus being obtained by the rack to the substage. The screws *s* and s_1 also serve to adjust the prisms accurately.

Hartnack's Illuminating Apparatus for Monochromatic Light.—The arrangement of prisms in the preceding apparatus is adapted

Fig. 86.



from that of Hartnack for obtaining monochromatic light. Two white flint-glass prisms P_1 and P_2 direct the rays passing through the slit Sp and collimator lens C, so that they are projected on the stage

through the lens at O. The milled head s_1 shifts the slit from side to side so as to bring various portions of the spectrum into the centre of the field, whilst that at s_2 opens and shuts the slit. The apparatus is attached to the substage at Spk. With ordinary daylight it is only available with low powers. With direct sunlight (and a heliostat) high powers can be used.

Physiology of Variable Apparent Magnification by the Microscope.*—In estimating the size of an object viewed in the Microscope, it is commonly assumed that the image is seen as if at the distance of easiest vision, which is taken to be 10 in. The invalidity of this latter assumption, Mr. W. Le Conte Stevens considers, is strikingly shown in the table of estimates exhibited and discussed by Prof. Brewer in his recent paper.†

"It is well known that the distance of easiest vision is variable during the life of the same individual. The 'near-point' for a normal eye varies from 3 in. for a child of three years, to 18 or 20 feet for a man of eighty, the power of accommodation diminishing with increase of age. For such an eye, when in a relaxed state, parallel rays will be converged to the exact distance of the retina. If the radiant point be but 10 in. distant, the sheaf of divergent rays from it, if transmitted through the same refracting medium, would be focalized behind the retina, were there not an instant contraction of the ciliary muscle, resulting in an increase of convexity of the crystalline lens at its front surface. The ease or difficulty with which this is done depends mainly on the age of the person, if the eye be normal. The effort exerted by a little child will be far less than that of an old man.

All that the Microscope can do is to increase the visual angle under which the object is seen, and hence increase the size of the retinal image. The extent to which this may be advisable depends upon several considerations well known to microscopists. Since the visual angle is simply the measure of the difference of direction between two rays passing axially through the crystalline lens, from the opposite marginal points of the magnified image, as seen through the eye-piece, it is quite possible for this to remain sensibly constant, while the refracting power of the crystalline lens varies. The adjustment of the eye-piece, or the distance of the eye from it, may vary while distinct vision is retained, the limits of variation depending upon the power of accommodation in the eye of the observer. For a hypermetropic eye, the rays from a given crossing-point near the focus of the eye-piece may emerge from the latter either parallel, or slightly convergent, or divergent, and yet be distinctly focalized on the retina in consequence of appropriate action of the ciliary muscle.

The interpretation which we put upon a retinal sensation is quite unconscious, and always accompanied with equally unconscious interpretations of attendant muscular sensations. The experience of the individual is the only guide in reading visual judgments. It is not

* Amer. Mon. Micr. Journ., iii. (1882) pp. 189–91.
† See this Journal, ii. (1882) p. 861.

at all remarkable that different persons should vary in the interpretation they put upon sensations produced under the same external conditions, although the general effect of controlling the condition of the eye among them may be much the same. The author has elsewhere detailed numerous experiments on this subject.* The result may be briefly stated by saying that, while the visual angle remains constant, an increase in the contraction of the ciliary muscle, or of the internal rectus muscle if both eyes be employed, produces the illusion that the object is much smaller and nearer. Under such conditions, the apparent diminution in size, together with imperfect focalization, may produce as a secondary effect the illusion that the visual angle has been diminished, and the imagination that the object is more distant. Thus the unmistakable illusion is that of diminution of size, and this may be coupled with great lack of determination in the judgment of distance. Upon the author the most usual effect is that of diminution of distance.

The internal rectus and ciliary muscles are supplied from the same nerve, and their contractions are usually simultaneous, though dissociation to a limited extent is by no means impossible. The relaxation of these muscles, with contraction of the external rectus, produces the illusion of greater distance and size for the object retinally pictured. This is in accordance with the laws of association; for, under ordinary circumstances, near vision requires contraction, and distant vision relaxation, of internal rectus and ciliary muscles; while unusual contraction of the external rectus muscles is not unfrequently necessary in the ordinary use of the stereoscope, involving discomfort and an illusion of increased distance in the binocular picture.

All our judgments, whether visual or otherwise, become vitiated when the conditions are very different from those to which we are most accustomed. Prof. Brewer's 440 observers accommodated their eyes, as nearly as possible, to the same external conditions. The striking diversity in the conclusions reached by them shows how various were the muscular conditions under which they interpreted their own sensations. To this must be added the important fact to which attention was called by him, that for the same eye much depends upon education. The mechanic who thought the picture looked to be 5 feet long, and projected upon a screen, was quite unaccustomed to forming judgments with no actual objects for comparison; and in any event there was, doubtless, room for improvement in his visional education.

Another striking example of variation in judgment by the same person, under changed ophthalmic conditions, is found in early experiences with the binocular Microscope by the original inventor of this instrument, Prof. J. L. Riddell, of New Orleans, La. In looking with both eyes at an object 10 in. distant, the two visual lines form an angle of a little over 14°, and a corresponding degree of contraction of the internal rectus muscles is necessitated. The two tubes of Dr. Riddell's first binocular Microscope were sensibly parallel, the sheaf of rays after passing through the objective being divided, and

* Amer. Journ. Sci., November and December 1881, April and May 1882.

each half subjected to two reflections before reaching the observer's eye. In a subsequent improvement, a pair of prisms were placed with the lower edges in contact, and rays transmitted with two refractions and one reflection, reaching the eyes in such manner that the optical angle was less than 14°. In either case, therefore, to adapt the eyes to this condition, the internal rectus muscles were relaxed, and a slight change of adjustment in the instrument was necessary. Dr. Riddell describes the result as follows:—'Thus, a mite of a wheel-animalcule, the 100th of an inch long, will perhaps appear to be a foot off, and as large as a mouse; but bring the prisms nearer together, and tilt the oculars to correspond, and the image waxes marvellously immense; and, taking a position perhaps apparently more than 100 feet distant, the being, too small to be seen with the naked eye, vies with the great whale of the ocean in size; wearing an aspect more awful to behold than the savage beasts of the African forests; exhibiting a complex transparent structure, more unique and wonderful than the mind of man can well conceive.'

We can good-naturedly forgive a little exuberance of imagination when the reality which it accompanies is the first revelation from such an instrument as that introduced to science by Dr. Riddell."

Visibility of Ruled Lines.*—Prof. W. A. Rogers states that he has ruled bands of lines in which the lines were so fine and delicate that they could not be seen with a Microscope, although their spacing was much within the power of the Microscope to resolve. Yet he was assured of the existence of the lines. The evidence in support of this assertion was of three kinds: the pressure of the diamond upon the glass was sufficient to produce a cut; the diamond produced a peculiar singing sound while moving over the surface, which is always indicative that it is working well; and finally, the lines become visible when filled with fine graphite.

There is a limit beyond which lines cannot be satisfactorily filled with graphite. It is difficult to fill lines finer than about 1-80000th or 1-90000th of an inch.

A most surprising result of some of the experiments of Prof. Rogers, is that the naked eye can discern not only single lines that cannot be seen with a Microscope, but that it can detect errors which the Microscope will not show. Thus, he has a bar upon which lines are distinctly visible to the unaided eye, and, although an objective of low power will show them, one of high power will not. But even errors or imperfections in ruling which cannot be seen or measured with the Microscope, may reveal themselves to the eye by a peculiar wavyness of the image. He attributes the failure of the objective to show the lines, as mentioned above, to the inability to illuminate the lines with light of the exact angle of incidence required, and the proper angle of illumination he thinks deserves more careful attention.

* Amer. Mon. Micr. Journ., iv. (1883) pp. 45–6.

Bale, W. M.—How to make an Eye-piece Micrometer. [*Post.*]
Southern Science Record, III. (1883) pp. 13–6.

Bond, G. M.—A Standard Gauge System.
[Describes a comparator and the Microscopes used and their illumination, &c.]
Journ. Franklin Institute, CXV. (1883) pp. 330–9.

Bradbury, W.—The Achromatic Object-glass, XVII.–XIX.
Engl. Mech., XXXVII. (1883) pp. 100–1 (2 figs.), 188–90 (5 figs.), 259–60.

Braman, B.—The usefulness of the Microscope as an Instrument of Recreation.
[President's Address to the New York Microscopical Society. The subject is dealt with under four heads. (1) The Microscope serves for diversion. (2) Microscopical recreation possesses the virtue of enthusiasm. (3) Recreations with the Microscope minister to benevolence and (4) serve for education.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 65–7.

Conversaziones, the Microscope at.
[Remarks on devices for preventing the coarse adjustment from being moved.]
Southern Science Record, III. (1883) p. 32.

Detmers, H. J. See Thomas, B. W.

Dolbear, A. E.—The Art of Projecting. A Manual of Experimentation in Physics, Chemistry, and Natural History, with the Port-Lumière and Magic Lantern. vi. and 158 pp. and 112 figs. 8vo, Boston, 1883.
[Includes projections of microscopical objects and the solar microscope.]

Dowdeswell, G. F.—Note on Cobweb Micrometers with the second web movable. [*Supra*, p. 422.]
Quart. Journ. Micr. Sci., XXIII. (1883) p. 337.

Flesch, M.—Beleuchtungsvorrichtungen zum Mikroskopiren bei künstlichen Lichte. (Illuminating Apparatus for microscopical observations by artificial light.)
[Vol. II. (1882) pp. 699 and 726.]
SB. Phys.-Med. Gesell. Würzburg, 1882, pp. 37–8.

Folsom, D.—A Home-made Substage Condenser.
[A piece of substage-tube is made to carry within it an objective to be used as a condenser. At the lower end of the tube, in which the objective is screwed, there is "a carefully-cut thread for focussing the objective operated by a milled head."]
Amer. Mon. Micr. Journ., IV. (1883) p. 46 (1 fig.).

Forbes, S. A. See Thomas, B. W.

Halley, J. J.—The Vice-President's Address to the Microscopical Society of Victoria. [*Post.*]
Southern Science Record, II. (1882) pp. 285–9.

Hitchcock, R.—Distortion produced by Camera-Lucidas. [*Post.*]
Amer. Mon. Micr. Journ., IV. (1883) pp. 43–5 (2 figs.).

,, ,, A Moist-chamber for Cultivation. [*Supra*, p. 428.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 56–7.

,, ,, An evening with *Amphipleura pellucida*.
[Results of testing the new 1-10th in. Spencer objective.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 57–8.

,, ,, Postal Microscopical Club.
[Note on the first box received this season.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 75–6.

,, ,, See Reddots, C.

Jennings, T. B.—A Work-table.
[A box-arrangement on the top of the work-table. "Internal height 18 in. There are two strong uprights let through the top and screwed to the hind legs of the table. The back is stationary, and is screwed on the outside of the two uprights; the sides swing by hinges from the back; the top is also hinged to the back and opens upward, and the front is in

turn hinged to the top. The sides are tongued to fit into grooves in the top and front. Some small shelves are arranged against the back."]

Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Moore, A. Y.—Testing Microscope Objectives.

[Bad centering and bad form tested by the mercury globule. Chromatic and spherical aberration by the mercury globule, a diatom, or *Podura* scale. Aperture by graduated rotating base or swinging substage bar. Flatness of field by *Echinus*-spine and blood-corpuscles. Also working distance and magnifying power.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 52–5.

Morrison's (W. J.) New Lamp-shade.

[Instead of the ordinary porcelain shade, a similar conical shade of tin is provided, having a cylinder extending nearly to the top of the chimney. A similar conical shade (without any chimney however) extends downward from the shade ring so that the light is entirely confined by the two cones—except what reaches the ceiling from the chimney. The lower cone has an opening of suitable shape and size to allow the light to be directed upon the mirror.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 63–4.

Park, R.—The Electric Light in Surgical Diagnosis. [*Supra*, p. 421.]

Knowledge, III. (1883) pp. 281–2 (1 fig.), from *Ann. of Anatomy and Surgery* and *Scientific American*.

Powell and Lealand's 1-12th in. Homogeneous-immersion Objective.

[*Ante*, p. 320.]

Engl. Mech., XXXVII. (1883) p. 104.

"Prismatique."—Object-glass Working. V.

Engl. Mech., XXXVII. (1883) pp. 99–100 (1 fig.).

Reddots, C.—On Objectives.

[As to "the difference in results between first quality and $15 lenses," and comment by Editor.]

Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Rogers (W. A.) on the Visibility of Ruled Lines. [*Supra*, p. 439.]

Amer. Mon. Micr. Journ., IV. (1883) pp. 45–6.

" " A Correction [of two or three errors in his paper on the "Conditions of Success in the Construction and the Comparison of Standards of Length."]

Amer. Mon. Micr. Journ., IV. (1883) pp. 78–9.

"Roi ne puis, Souza je suis."—Grunow's new Camera-lucida.

[Described *ante*, p. 120, and *supra*, p. 423.]

Engl. Mech., XXXVII. (1883) p. 154 (1 fig.).

Soret, C.—Sur un réfractomètre destiné à la mesure des indices et de la dispersion des corps solides. (On a Refractometer for measuring the refractive indices and dispersive powers of solid bodies.)

Comptes Rendus, XCV. (1882) pp. 517–20.

Abstr. in *Zeitschr. f. Instrumentenk.*, II. (1882) pp. 414–5.

Stowell, C. H.—Our new 1-50th Objective.

[Made by Spencer—four systems—1·17 N.A. Working distance about 1-100th in. Used with homogeneous-immersion fluid, glycerine or water.]

The Microscope, III. (1883) pp. 14–15.

Thomas, B. W.—Resolving *Amphipleura pellucida* with central light.

[Accompanying letters from H. J. Detmers and S. A. Forbes.]

The Microscope, III. (1883) pp. 9–12.

β. Collecting, Mounting and Examining Objects, &c.

Preparing and Cutting Amphibian Eggs.*—Although the amphibian egg has long been a favourite object of study among embryologists—and quite as much so since section-cutting came into vogue as before—comparatively little progress has been made in overcoming the difficulties that attend its preparation for the microtome. The chief difficulties are found in freeing the egg from its gelatinous envelope, and preparing it so as to avoid brittleness.

The best method that has thus far been proposed for these eggs is unquestionably that of O. Hertwig, and Dr. C. O. Whitman † therefore gives it in detail.

1. In order to facilitate the removal of the gelatinous envelope, the eggs are placed in water heated almost to boiling (90–96° C.) for 5–10 minutes. The eggs are thus coagulated and somewhat hardened, while the envelope separates a little from the surface of the egg and becomes more brittle. The envelope is then cut under water with sharp scissors, and the egg shaken out through the rupture. With a little experience a single cut suffices to free the egg.

2. By the aid of a glass tube the egg is taken up and transferred to chromic acid (½ per cent.), or to alcohol of 70, 80, and 90 per cent. Chromic acid renders the egg brittle, and the more so the longer it acts; therefore the eggs should not be allowed to remain in it more than twelve hours. While eggs hardened in chromic acid never change their form or become soft when transferred to water, those hardened in alcohol, when placed in water or very dilute alcohol, lose their hardness, swell up, and often suffer changes in form.

3. Alcoholic preparations are easily stained, but chromic acid preparations are stained with such difficulty and so imperfectly that Hertwig omitted it altogether.

There is an important difference between alcohol and chromic acid in their effect on the pigment of the egg. Chromic acid destroys the pigment to some extent, and thus obliterates, or at least diminishes, the contrast between pigmented and non-pigmented cell-layers. As the distribution of the pigment is of considerable importance in the study of the germ-lamellæ, it is well to supplement preparations in chromic acid with those in alcohol, in which the pigment remains undisturbed.

4. Eggs hardened in chromic acid were imbedded almost exclusively in the egg-mass recommended by Calberla. The great advantage offered by this mass is, that it supplies a sort of antidote to the brittleness of the egg. It glues the cell-layers together, so that the thinnest sections can be obtained without danger of breaking.

5. As the dorsal and ventral surfaces, and the fore and hind ends can be recognized in very early stages, it is important to know precisely how the egg lies in the egg-mass in order to determine the

* Jen. Zeitschr. f. Naturwiss., ix. (1882) p. 249.
† Amer. Natural., xvii. (1883) pp. 272–4.

plan of section. In order to fix the egg in any given position in the imbedding mass, Hertwig proceeds as follows:—

a. A small block of the hardened mass is washed in water to remove the alcohol, and in the upper surface of the block, which has been freed from water by the aid of filtering paper, a small hollow is made. This hollow is then wet with the freshly-prepared *fluid* mass.

b. The egg is washed in water to remove the alcohol, placed on a piece of filtering paper to get rid of the water, turned on the paper by a fine hair brush until it has the position desired; the point of the brush is next moistened and pressed gently on the upper surface of the egg; the egg adheres to the brush, and may thus be transported to the hollow prepared for it in the block.

c. After the egg has thus been placed in position, a drop of absolute alcohol carefully applied will coagulate the "fluid mass" with which the hollow was wet, and thus fix the egg to the block. The block is again washed, and finally imbedded in the egg-mass, which is prepared in the following manner.*

The white of several eggs is separated from the yolk, freed from the chalazæ, cut with shears, and thoroughly mixed by shaking with a 10 per cent. solution of carbonate of sodium (15 parts of the white to 1 part of the solution). The yolk is next added, and the mixture shaken vigorously. After removing the foam and floating pieces of yolk by the aid of filtering paper, the so-called "egg-mass" is ready for use. It is this fluid with which the hollow in the solid block is wet, as before mentioned, the block itself being only a piece of the same mixture after it has been hardened in alcohol.

Calberla soaks the egg a few minutes (5–20) in the fresh white of the egg before imbedding. Hertwig appears to omit this part of the process.

After the egg has been fixed to the block as before indicated (*c*), it is placed in a paper box and covered with the fresh mass (1–2 cm. deep). The box is then placed in a vessel that contains alcohol (75–80 per cent.), enough to bathe its lower half; the vessel, covered with a funnel, is heated over a water-bath for 30–40 minutes, care being taken not to *boil* the alcohol. The imbedding substance, thus hardened, is next placed in cold alcohol (90 per cent.), which should be changed once or twice during the first twenty-four hours. After remaining in alcohol for about forty-eight hours, the imbedded egg is ready for cutting.

Preparing Sections of and Examining Embryos.†—The second edition of Foster and Balfour's 'Elements of Embryology' contains an Appendix, in which are given some very succinct directions for preparing sections of the embryo of the chick, divided into three heads:—(1) *Hardening* (picric acid, corrosive sublimate, osmic acid, chromic acid, and alcohol); (2) *Staining* (hæmatoxylin, borax-carmine, carmine, picro-carmine, and alum-carmine); (3) *Imbedding* (in paraffin);

* Calberla's method of imbedding. Morph. Jahrb., xi. (1876) p. 445.

† Foster and Balfour's 'Elements of Embryology,' 2nd ed. (1883) pp. 423–70.

(4) *Cutting* and *Mounting Sections*. Directions are also given for obtaining embryos from the earliest stages to the fourth day, and for their examination as transparent or opaque objects.

The rabbit is similarly dealt with, commencing with ova from one to sixty hours old to embryos of fourteen days.

Imbedding.*—Mr. J. S. Kingsley describes the following method of imbedding:—

"The substance to be imbedded is hardened after any of the usual methods, and placed from alcohol into turpentine, then transferred to a saturated solution of paraffin in turpentine, the same as in other methods of paraffin imbedding. Here is where the novelty comes in. The specimen is removed from the mixture, and the superfluous fluid removed by means of blotting paper, and then placed on a cylinder of paraffin (or paraffin and vaseline). A piece of stout iron wire is now heated in the flame of a spirit-lamp, and with it a hole is melted in the end of the cylinder, and the specimen then pushed into the melted paraffin, and placed in any desired position.

The advantages of the method are: the quickness with which it may be performed, for from the time when the operation is begun until sections can be cut is not over three minutes, while the melting of so small an amount of paraffin prevents any injury to tissues by overheating. In imbedding solid bodies a slight variation sometimes results in the saving of more time. The specimen may be imbedded directly from alcohol without the intervening turpentine, and then when the section is cut it readily separates from the shaving of paraffin without the use of turpentine to dissolve it. This, of course, applies to solid bodies without cavities or irregular outline."

Mounting Insects in Balsam without Pressure.†—Mr. H. Chadwick gives the following directions:—

Preparation.—I. Soak the specimens in liquor potassæ until they are transparent. Wash well in distilled water, using a pipette and camel-hair pencil. Transfer to 50 per cent. spirit, then to a small quantity of pure spirit in a watch-glass or soaking bottle, and allow them to stand for some hours. Then add oil of cloves, and allow the spirit to evaporate. By this method, the formation of air-bubbles in the interior of the specimens may generally be avoided.

II. Wash well in distilled water. Soak in pure spirit or alcohol for some days. Transfer to carbolic acid until sufficiently transparent. Then transfer to oil of cloves, but many mounters do not consider this necessary. This method should be used in all cases where the integument is not too opaque to allow light to pass through it before treatment, and it is especially useful in the study of the muscles.

Mounting.—Take a clean 3 × 1 slip, having a sunk cell in its centre. Just inside the edge of the cell, equidistant from each other,

* Amer. Mon. Micr. Journ., iv. (1883) p. 58, from 'Scientific and Literary Gossip.'

† Micr. News, iii. (1883) pp. 105-6 (1 fig.).

cement three white glass beads with hardened balsam. Put a small quantity of soft balsam in the centre of the cell, and gently warm it over a spirit-lamp. Take the object, a wasp's or blow-fly's head, for example, and place it upon the previously warmed balsam, arranging it in the required position. Now take a clean cover-glass, the diameter of which should be a little less than that of the cell, and holding it between the points of a pair of forceps, place a large drop of balsam in its centre, and allow it to fall upon the object. The edge of the cover should rest upon the three beads. If the quantity of balsam under the cover-glass is not sufficient to fill up the whole of the space between it and the slide, a little more must be allowed to run in, and if the object has become displaced, it may be rearranged by means of a fine blunt needle, introduced beneath the cover-glass. A clip should be used during the last operations, but only to prevent displacement of the cover. The slide must now be put aside in a warm place, until the balsam is hard enough to allow the superfluous portion to be removed safely. Sufficient balsam should be left to form a sloping edge around the cover-glass, and it should be hardened for a few days after cleaning. Be sure that the balsam is quite hard before applying brown cement. The ease with which an object can be re-arranged, or a chance air-bubble removed, without disturbing the cover-glass, constitutes the chief advantage of using beads. A supply of different sizes should be kept, and the size used must be regulated by the thickness of the object. Pure balsam in collapsible tubes is to be strongly recommended, on account of the nicety with which the quantity of balsam required for mounting a slide can be regulated. The neck of the tube should be wiped with a clean cloth moistened with benzole before the screw-cap is replaced, in order to prevent the possibility of a little balsam hardening in the screw, and so prevent the easy removal of the cap when next required.

Reagent for Simultaneous Staining and Hardening.*—In view of the objections to the various combinations of staining and hardening reagents hitherto employed, E. Pfitzer, in order to meet the requirements of vegetable microscopy, has devised a fluid which both hardens and stains. It consists of the colouring matter, nigrosin, dissolved with picric acid, in water or alcohol.

a. To a concentrated watery solution of picric acid is added a small quantity of a watery solution of nigrosin; if the object to be studied contains much water, some crystals of the acid are added, in order to maintain the strength of the liquid.

The deep olive-green fluid kills with great rapidity. After some hours' immersion of the object which is to be examined, it may be transferred to common spirit, especially if it is desirable to dissolve out chlorophyll, &c., or if the object has to be kept for some time. By this means the denser masses of protoplasm are stained pale violet, the chromatophores darker, while the pyrenoid, nucleoli, and other coloured parts of the cell-nucleus come out deeply stained; thin

* Ber. Deutsch. Botan. Ges., i. (1883) pp. 44–7.

films of protoplasm and ordinary cellulose membrane are scarcely, if at all, stained, starch-grains not at all. By washing the objects in *water* after staining, instead of in spirit, a grey-blue colour is obtained: transference to concentrated glycerine makes the colour purer. The colour comes out best, however, after washing in alcohol, treating with oil of cloves and mounting in one of the resins (dammar or Canada balsam). To avoid contraction, the clove oil may be diluted with alcohol and allowed to concentrate upon the object by evaporation of the alcohol. The watery solution is especially adapted for rapidly killing and staining objects already under the Microscope.

b. Nigrosin and picric acid may also be used in solution in alcohol; the solid acid and nigrosin are left for some time in absolute alcohol; by this solution the chromatophores and pyrenoid are less deeply stained, the coloured contents of the nucleus very deeply so.

Anilin Colouring Matters as Staining Media for Human and Animal Tissues.*—Dr. H. Griesbach discusses the value of anilin colours as staining media for human and animal tissues, and gives the results of his own experience. His paper is not capable of useful abstract, being already in a condensed form, but the following brief account is given to call attention to its existence and to enable reference to be made to the original.

Anilin-yellow he considers unsuitable. *Säure-gelb* colours bone a beautiful orange, tracheal cartilage and connective tissue lemon. In sections of the intestinal sac of *Unio* the epithelium is orange, muscle gold, glandular tissue brownish, and the nuclei of the cells are very clearly shown. Nerve-elements are not so well coloured, nor any isolated cells except gland-cells. It does not appear to be suitable for chromic acid preparations. *Chrysoidin* is useful for bone and all kinds of connective tissue, which it colours a bright yellow. Its best effect is with fresh preparations. *Bismarck brown* has its best effect with nuclei (either alcohol or chromic acid preparations) and unicellular organisms, bacteria of all kinds, colourless blood-corpuscles, &c. *Tropæolin*, Y, 0, 00, 000 No. 1, and 000 No. 2. The first is good for human spinal cord hardened in chromic acid, and alcohol preparations of bone, the others serve for connective tissue, cartilage, nuclei, and bone. The colours are lemon-yellow, straw-yellow, orange, orange-red, and brown. *Crocein* he has found to be a very useful medium. It colours bone, cartilage, muscle, and connective tissue (whether fresh or alcohol or chromic acid preparations) a beautiful purple-red. *Rocellin* colours bone and connective tissue, muscle, glands, and epithelium cherry-red. *Xylidinponceau*, *Ponceau* R R, G, and G G are not suitable for chromic acid preparations. The first gives good colours with bone, connective tissue, and muscle. The second gives red and scarlet-red colours. The third colours bone dark orange; connective tissue, muscle, and epithelium saffron-yellow; nerve substances bright yellow. The fourth has only been found useful for bone, gelatinous connective tissue, and muscle, which it colours a bright

* Arch. f. Mikr. Anat., xxii. (1883) pp. 132-42.

orange. *Bordeaux* R and G. colour the three last mentioned substances, nuclei, and glandular tissue, the former giving a red and the latter a more yellow tint. Fresh are less successful than alcohol preparations. *Biebrich scarlet* colours the most different tissues deep red. It is not suitable for chromic acid preparations. Cell-nuclei stand out sharply. *Gold-orange* serves for fresh or alcohol or chromic acid preparations. Bone is deep orange-red, cartilage gold, connective tissue reddish. It is especially valuable for glandular tissue; it gives a splendid appearance to liver injected with Berlin blue, the blue vessels showing on a gold ground; sections of skin give fine images.

The preparations after washing and clearing are best mounted in balsam. Oil of cloves is mostly used for clearing. Very delicate colours are, however, often injured by the yellow of the oil of cloves, and in such cases oil of lavender should be substituted, or a quite colourless oil of aniseed.

Dr. Griesbach gives a word of caution against the too hasty abandonment of the older media in favour of the new anilin colours, pointing out in regard to their use in permanent preparations that our experience of their durability is not yet long enough. Whatever the future may bring, however, in this respect, they cannot fail to be of the greatest use in histology.

Double Staining Nucleated Blood-Corpuscles with Anilin Dyes.*—Dr. V. Harris describes a series of experiments the object of which was to find out the best combination of anilin dyes for double-staining. With hæmatoxylin and picrocarmine it is believed that a definite effect may be always calculated upon when they are used in combination. With anilin stains, however, the results arrived at appear to differ very materially if the methods of employment are made to vary in even a very slight degree. It is only in the case of a very few combinations that any certain result has hitherto been expected.

The only entirely successful combinations were the following:—Rosein and anilin green; fuchsin and methylen blue; fuchsin and Bismarck brown; eosin and vesuvin; iodine green and Bismarck brown; Hoffman's violet and Bismarck brown; anilin violet and methylen blue.

The green dyes were not at all permanent. This was proved with both malachite and iodine greens.

Even with the above successful combinations the results varied in a most extraordinary manner, whilst the circumstances of the staining operation and the solutions appeared to be unvaried, the very greatest care being required to produce a constant result. One thing necessary for success was certainly that the solutions should be quite fresh. This is likely to prove a great objection to the general introduction of anilin dyes into use.

The result was materially affected by the time each dye was allowed to remain in contact with the blood.

* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 292–301.

Dr. Harris gives the following classified list of the chief anilin dyes, with their solubilities in water and in spirit.

Brown.	Red.	Orange.	Yellow.	Green.	Blue.	Violet.
Bismarck — partially soluble in water; soluble in dilute spirit.	*Eosin*, pink — freely soluble in water.	*Aurin*—insoluble in water; partly soluble in strong spirit; more so in absolute alcohol.	*Fluorescein*, greenish yellow—insoluble in water; soluble in spirit, the solution being beautifully fluorescent.	*Iodine Green*, blue green — freely soluble in water or spirit.	*Soluble Anilin Blue*—freely soluble in water.	*Hoffman's Violet*—freely soluble in water and in dilute spirit.
Vesuvin—soluble in water.	*Anilin Scarlet*—insoluble in water; freely so in methylated spirit.	*Anilin Orange*—ditto, ditto.	*Anilin Primrose*—only partly soluble in methylated spirit.	*Malachite Green*, a less blue green—freely soluble in water and in spirit.	*Bleu de Lyon*—insoluble in water; freely so in strong spirit.	*Methyl Violet*, the red predominating — soluble in water partially; freely soluble in spirit.
Chrysoidin—soluble in water.	*Flamingo*, deep brownish red—partly soluble in water; freely so in methylated spirit.	*Tropæolin*, in deep yellow glistening scales—partly soluble in water; more so in methylated spirit.			*Methylen Blue*, a very deep blue—freely soluble in water, and in spirit.	*Gentian Violet*, the blue predominating—freely soluble in water.
	Ponceau,* deep red crimson—partly soluble in water; freely in dilute spirit.	*Phosphin*, yellowish orange—partially soluble in water; more so, but not freely, in spirit.			*China Blue*—freely soluble in water.	*Tyrian Blue*, near to violet—soluble in water.
	Rosanilin—partly soluble in water; freely soluble in dilute spirit.	*Saffranin* — soluble in water and in spirit.			*Serge Blue*—ditto.	*Spiller's Purple*—soluble in spirit.
	Fuchsin — partly soluble in water; soluble in dilute spirit.				*Blue Black*—freely soluble in water.	

* Ponceau is a mixture of rosanilin and phosphin.

Deecke's Microtome.—Cutting and Mounting Sections through the Entire Human Brain.*—Dr. Deecke's microtome used for this purpose is a heavy brass cylinder of the Ranvier form, and is 9 in. in diameter and 14 in. high. The piston can be raised by the screw with great accuracy, the 1200th, the 600th, the 400th, &c., part of an inch, thus by the aid of an index graduating the thickness of the sections. As the sections must be cut under alcohol, the microtome is inserted in a basin of copper, 18 in. by 30 in. by 4 in., placed on a suitable table frame. The brain to be cut is placed upon the piston and held *in situ* by several pieces of soft cork. It is then imbedded in a cast of paraffin, olive oil, and tallow which, after it has become hard, is held in position by a number of small curved rods attached to, and projecting upwards from the piston to the height of about an inch. Before cutting, and as it proceeds, the cast is carefully removed from around the specimen to the depth of about ½ in. (which is easily done by the use of a good sized carpenter's chisel), so that the knife never comes in contact with the cast.

The knife has a blade to which upright handles can be fastened by screws; the cutting edge is 16 in. in length, the blade 1½ in. broad, and 1-4th in. thick at the back. To this a steel rod is attached by screws, which project 1-16th in. downwards, so that the knife, when placed upon the microtome, rests only upon its edge and the rod, leaving a free space between the lower surface of the blade and the upper of the cylinder, by which arrangement the alcohol is allowed access to this space, thus preventing almost entirely adhesion between the two surfaces. The general form of the knife is that of a chisel. When the instruments are made accurately their construction enables the operator to move the knife forward with a slight sawing motion or, better, in short cuts, while the weight of the knife itself fully suffices to prevent any deviation from its course, and renders it unnecessary to use any amount of pressure. This manner of cutting of course requires practice and a light, firm, and steady movement of the hands. It becomes necessary, after each step forward, to draw the knife a little back, in order to be sure of not losing a particle of the section. The sections will, it is true, show slight traces from this way of cutting; this does not, however, interfere in the least with the examination of the specimens or with their beauty; in fact, they are so slight that they can scarcely be recognized after the sections are mounted. Moreover, the longer the instruments are in use the more perfect they become when carefully kept and handled.

This method offers great advantages over that by one sweep, in that the sections come out much more uniform in thickness and more perfect in all their parts, and the loss in a series of successive sections of from four hundred to five hundred to the inch—for example through the entire cerebrum of man—by an experienced operator, may not amount to more than 2 or 3 per cent. Furthermore, there is no necessity, as in the German method of cutting in one sweep (Gudden's), to remove, before hardening an organ like the brain, the

* Description supplied by Dr. Deecke (slightly condensed). See also Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 275–7, 279–80.

membranes, the choroid plexus, &c., which can never be done without extensive injury to the specimen, often rendering impossible the preservation of the structure of its most delicate parts or, in pathological preparations, preventing the full presentation of the morbid appearances. In the majority of cases a most important link in the chain of pathological evidence may thus be lost.

The sections, even of the largest size, are handled, without difficulty or danger of becoming torn, by floating them (in the basin, filled with alcohol in which they were cut), with a fine camel's-hair pencil on sheets of glazed writing-paper, to which they will not adhere as long as the paper is kept wet. They will adhere sufficiently however, to be easily removed when the paper is slowly raised by one corner. They are thus transferred with the paper, which is at once numbered and marked, as desired for storing them away or into the staining fluid, the washing or the fixing fluid, &c., and the oil for clearing them up. From thence, when placed on the mounting slide, the sheet of paper can easily be pulled off, which can be done without injuring the delicate specimen in the least. It is then advisable to put all parts of the section in their proper position and to remove all foreign material visible to the eye, aided by a low magnifying lens. After most of the oil has been removed by placing the slide gradually, for a short time, in a vertical position, the section will adhere so firmly to the glass surface that the mounting fluid can be poured on it and the cover adjusted without displacing any of its parts. It is necessary, however, to remove at once, and as quickly as possible, by the use of blotting-paper, any surplus of mounting fluid, and to drive out all air-bubbles by gentle stroking pressure on the cover-glass from the centre towards the periphery.

The sections are preferably mounted in balsam, diluted with chloroform or benzole, on plate-glass slips 5 in. by 7 in., and 6 in. by 8 in. and 10 in., and with proper care no more difficulty from air-bubbles is found with these than with the ordinary slides.

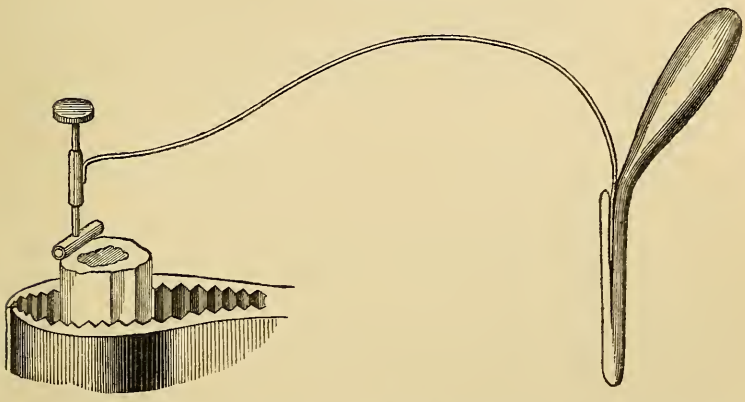
To harden the entire brain so that the inside and the outside shall be hardened equally and properly, Dr. Deecke finally adopted bichromate of ammonia in ½ to 1 per cent. solution, according to the consistence of the brain. When nominally soft he adds say 1-6th to 1-10th per cent. of chromic acid to the solution, and always 1-6th to 1-4th of the whole volume of alcohol. It is then placed in a refrigerator and the fluid changed frequently. After a month add a little more alcohol from week to week until the alcohol is 90 per cent. This is changed as often as it is discoloured. The treatment requires from 12 to 18 months.

Schulze's Section-stretcher.*—Dr. F. E. Schulze holds down the section whilst it is being cut, preventing it from rolling up, by means of a small weight, shown in fig. 87. This weight, which is about 8 mm. long and rounded at the ends, is attached to a small steel rod. The rod passes through a tube, so that it can easily be turned within it, and slipped up or down. To this tube is soldered a thin watch-

* Zool. Anzeig., vi. (1883) pp. 100–3 (1 fig.).

spring, the other end of which is bent down vertically, and fastened in the cleft of a split peg. This has a long oval handle projecting upwards obliquely, and it is fixed in a hole in the object-holder of the microtome, to a depth of from 2 to 3 cm. It can be turned in this

Fig. 87.



hole, and fixed more or less deeply as desired, whereby the end of the spring and the weight can be moved to a considerable extent laterally or slightly perpendicularly.

In practice, the position of the hole for the reception of the split peg must be so arranged relatively to the length and curvature of the spring, that the small weight rests lightly along its whole length on the anterior part of the upper surface of the paraffin mass to be cut. This can be easily managed by a slight lateral movement of the end of the spring in the cleft of the peg. By turning the perpendicular steel rod attached to the weight, the latter can be made parallel with the edge of the knife. Slight alterations in the pressure of the weight can be made by raising or lowering the rod in its tube; greater alterations, by a slight bending of the spring.

On cutting the section the tendency of the anterior end to rise and roll up will be restrained by the weight, and thereby the whole section be prevented from rolling up. As the knife advances the weight slides upon the blade, and the section always remains flat and even, with one end held down by the weight and the other adhering to the edge of the knife.

It is easy to adjust such a section-stretcher to any sliding microtome.

Preparation of Marine Algæ.*—Working under the inspiration of Dr. Paul Mayer, G. Berthold has experimented with iodine and other reagents on delicate marine algæ. The aim was to find solutions that would produce the least possible disturbance in the structure of the cell-protoplasm. It was found that satisfactory results could not

* Pringsheim's Jahrb. f. Wiss. Bot., xiii. (1882) pp. 704–5. Cf. Amer. Natural., xvii. (1883) pp. 456–7.

be obtained with the ordinary aqueous solutions of picric acid, osmic acid, &c. The disturbance of the osmotic equilibrium, on transferring delicate cells from sea-water to fresh-water solutions, resulted in intracellular derangements. Parallel trials were therefore made of picric acid, osmic acid, and iodine, three different solutions of each being made; one in distilled water, one in alcohol, and another in sea-water. The solutions in distilled water and alcohol proved almost worthless in each case, while each of the solutions in sea-water gave good results. It was found, curiously enough, that the protoplasm of the cells was more easily injured than the nuclei and karyokinetic figures.

Solutions of osmic acid and corrosive sublimate in sea-water gave good preparations, but the iodine solution was regarded as the best reagent.

A few drops of a saturated alcoholic solution of iodine, added to the sea-water, gives the desired results. The algæ remain in the solution $\frac{1}{2}$–1 minute, and are then transferred directly into 50 per cent. alcohol.

Dr. C. O. Whitman considers this a valuable method which may be of considerable importance to zoologists as well as to botanists.

Arrangement of Diatoms.*—M. P. Barré gives the following directions:—

Canada balsam is spread by a metal or ivory blade a few millimetres in breadth on a cover-glass, so as only to leave a layer of extreme thinness. The balsam will become hard if the cover-glass thus prepared is warmed over a spirit-lamp; bubbles will form if the heat is too great, but these are easily avoided by care during the heating, and the balsam forms a hard brittle enamel, free from streaks and blisters. This heating should be prolonged until the balsam becomes modified in colour and slightly reddened. The cover-glass is then placed on a black ground, and we proceed to the arrangement of the diatoms by means of a very fine eye-lash fixed in a handle, using the Microscope to pick them out and a strong magnifier to arrange them on the smooth and even surface of the balsam. When the diatoms are in place, we ascertain whether they are perfectly straight, and those which are not in their proper place are lightly slipped along by means of an eye-lash soaked in chloroform, in order to remove all grease from it, and prevent the diatoms from sticking to it.

The cover-glass is then again slowly heated. The balsam becomes again softened, and the diatoms sink into it, and, without altering their arrangement, become semi-transparent, at which point the heating must be stopped.

Many lines may thus be arranged on the same cover-glass, the balsam being reheated several times, in which case it is better not to overheat it the first time, in order to avoid its becoming reddened by repeated applications of heat.

The cover-glass with the diatoms has now to be fixed on the slide.

* Bull. Soc. Belg. Micr., ix. (1883) pp. 74–7.

A drop of balsam, about the size of a grain of pepper, is placed on the slide, and the latter put, *with the balsam on the under side*, on a horizontal plate pierced with an aperture 4 cm. in diameter, and allowing of movement to the extent of about 10 cm. up and down by means of a rack and pinion. The spirit-lamp is put below the aperture in the plate, and consequently underneath the drop of balsam on the slide.

The flame of the lamp ought to be very small. Sudden heating must be carefully avoided. On the neck of the lamp a tube is fixed, which serves as a chimney. Its object is to make the flame steady, and prevent its flickering.

The drop of balsam is soon seen to oscillate; the chloroform which it contains evaporates, and after about a minute of heating there remains a small solid hemisphere, whose hardness should be kept below that of the balsam which secures the diatoms. If any bubbles are formed, they should be removed with a needle, in such a way as not to alter the regular shape of the hemisphere.

After it is perfectly cold the slide is turned over, and on the hardened drop is placed, exactly centrally, the cover-glass holding the diatoms. Heat is then applied gradually, and the cover-glass (if necessary, held in its place by a needle) slowly settles down and finally rests flat on the slide. There is no reason to fear any alteration in the diatoms in consequence of its weight, as the author has never found any trace of disarrangement, even with the most delicate diatoms. If the quantity of balsam forming the drop has been well calculated it will form round the cover-glass a raised edge, very neat in appearance, and dispensing with the external ring of varnish.

The preparation is then complete: the diatoms are inclosed in a real matrix of enamel which abnormal heat alone can soften. Exposed to the summer sun in a closed apartment no disturbance of the arrangement of the diatoms takes place.

In the last operation bubbles often form which disfigure the preparation. These may be avoided by introducing, with a needle, a very small drop of common oil in the centre of the cover-glass.

The process may be applied for mounting diatoms dried into dust. In this case there must be spread on the cover-glass a small quantity of balsam made very fluid with chloroform, in order to secure its being as thin as possible, and the heating and mounting are then proceeded with as above described.

On the occasion of the paper being read, a practical demonstration of the process was given, of which it is said that the "preparation was perfectly successful, and was not inferior to the celebrated slides of Möller. It may be said that if the process of Möller remains unknown the means of rivalling him is at least discovered. The members were above all struck with the great simplicity of the manipulations."

Paper Cells.—Mr. G. Busk writes as follows:—

"As I have found the use of paper cells very convenient for the mounting of objects where it is advantageous to avoid compression beyond a certain point (as for instance Hydroids, Polyzoa, &c.), I

have thought that a few hints on the mode of preparing such cells might interest others.

The porosity of ordinary paper is of course an insuperable bar to its employment for cells intended to be filled with watery or even with resinous or oily media; but when the porosity is got rid of, the facility with which cells may be made of paper of varying thickness renders them very convenient. The paper may be rendered perfectly non-absorbent if it is saturated with a resinous substance, which should at the same time maintain, when dry and hard, its adhesion to the glass.

Paper used for this purpose should be more or less spongy or porous, such as ordinary printing paper, or the cheaper kinds of writing paper, and the cells when made should be allowed to soak for some time in the resinous menstruum, until they are completely saturated with it. When in this condition they should be taken out dripping, and placed in proper position on the slide, care being taken that no air-bubbles are left between the paper and the glass.

There are, no doubt, numerous compounds that may be used as the cement. That which I have found convenient and suitable for the purpose of saturating the paper, and insuring its permanent adhesion to the glass, is the ordinary solution of canada-balsam-resin in benzole. But when used for this purpose the balsam should not have been completely desiccated, otherwise a little turpentine should be added to the solution.

The cells should be allowed to dry and harden for several days, when the superfluous balsam can be washed off with a little benzole and spirit.

These cells are perhaps particularly adapted for watery media, such as glycerine or Farrant's medium, but they serve very well also for balsam or castor-oil. Of these media, it seems to me that Farrant's is the most generally useful and most convenient in use.

In conclusion I may remark that, in mounting an object, great convenience will be found in the use of a small lead weight (2 or 3 oz.) supported on three short pins. This allows of the cleaning of the edges of the cover-glass, and the application of varnish of any kind to fix the glass and prevent the entrance of air. After having been kept for a day or two under the weight, the cell may be finished off in any way that may be desired. But there is one point with respect to the finishing off that should be noticed if the usual zinc-white paint is employed. This material appears to possess a great power of insinuating itself under the cover, and thus disfiguring the preparation, if the cell has been merely sealed with a resinous cement. The evil, however, can be completely avoided by the application over the cement of a little gum-mucilage, through which, when dry, the zinc-white has no power of penetration."

Making Tinfoil Cells.*—Professor A. H. Chester believes that cells from pure tinfoil satisfy better than any others the conditions

* Proc. Amer. Soc. Micr., 5th Ann. Meeting, 1882, pp. 282–3. See also this Journal, i. (1881) pp. 702–3.

of being permanent, not affected by heat or cold, and being cheap and easily worked. Tinfoil ·03 in. thick is the more generally useful. The rings can be punched out by two punches of different size. It is almost impossible to make the two circles concentric and smooth, so after a number are punched out they should be placed on a maudrel fitting the inner circle exactly, and putting it in a lathe, turn down the outside perfectly true. If deeper cells are wanted it is easy to cement any number of the rings together.

Professor A. McCalla finds it easier, after punching out the inner hole, to cut the rings apart with scissors, without attempting to make them round on the outside as lathe cutting does that perfectly. It will probably be a good plan to fit rotary cutters on the lathe to cut out several consecutive circles at once somewhat as leather washers are cut.

Ivory Drop-Black.*—Mr. E. Graham uses this material† as a background for all opaque mounts. It makes when properly applied a beautiful smooth surface.

Press a small quantity of the colour into a one-ounce wide-mouth bottle, and thin it sufficiently with *fresh* turpentine. The slide being on the turntable, apply the colour with a brush. If the colour is too thick, it will be found that it cannot be smoothly spread, and that it will dry in ridges. If too thin it will be found necessary to make several applications. If it is necessary, a second application can be made within fifteen or twenty minutes.

Selection of Cover-glass.‡—Dr. J. E. Smith tries to confine himself to three thicknesses of cover-glass, namely 1-70th in., 1-120th in., and 1-200th in. These may respectively be denominated as thick, medium, and thin. It is a matter of the first importance that those working first-class objectives should be well posted as to the thickness of cover employed, and yet this telling point has been utterly lost sight of in the books. For example: by knowing the thickness of the cover, one is enabled to approximately adjust the objective at sight, and thus save time. He has thousands of mounted objects in his cabinets, and every cover has been measured with all the accuracy obtainable. Those who have long had their attention called to this matter can, by dint of practice thus obtained, tell closely the thickness of the cover by simply *feeling* it; and this, he assures the novice, is an accomplishment worth having.

"To take a case from practice: Suppose I desired to examine a brand-new mount. Let it be a difficult diatom this time. First, I run my finger over the cover, and instantly discover that it is a thin one, say about like those used on the Möller plates. Now, if I elect to use the 1-6th objective, I know that this cover is too thin for water immersion; hence glycerine is chosen. I know, too, that over such a cover, and with the glycerine intermedium, the objective will correct some three or four divisions from closed, therefore the collar is at

* Amer. Mon. Micr. Journ., ii. (1881) p. 113.

† The "XXX ivory drop-black" of Sherwin Williams and Co., of Cleveland, Ohio, put up in collapsible tubes and ground in japan, and not in oil, which will not do, as it always dries with more or less gloss.

‡ 'How to see with the Microscope,' 1880, pp. 213-15.

once placed near such position. Now, on looking through the tube at the object in position and focussed, suppose I do not get as good views as I had reason to expect, then *I let the collar stand as it was*, and change the illumination until things are approximately as desired; this done, a slight turn of the collar adjustment will insure the maximum working of the objective. Now just contrast this with the usual *modus*. Eight operators out of ten would have at once twisted round the collar, haphazard-like, by 'rule of thumb,' probably wasting plenty of time, and, more unfortunately still, condemning a really good objective, and one that would have, with the proper manipulations, given charming displays."

Labelling Slides.*—Mr. S. Lockwood describes a device which he has found of much service in labelling slides. It often happens that the label does not afford room enough to contain the facts which should accompany the specimen. In such cases he writes all he can on the *back* of the label with a medium hard pencil, and then, with a mucilage made of gum arabic one part and gum tragacanth four parts, attaches the label to the slide in the usual way. As soon as dry, the labelling is finished by writing the rest in ink on the upper, or face side, of the label. The pencil writing on the back can be easily read through the slide simply on turning it over. In this way both sides of the label are utilized.

Economical Cabinet for Slides.†—Dr. B. A. Randall, referring to the want he has found for some form of cabinet which would hold securely several hundred slides and yet would not be expensive, describes, as the result of some experimentation, the following arrangement:—

It consists of trays of binder's board of two sizes, the large 11 by 8 in., the smaller 11 by 4 in. Each of the smaller consists of a solid bottom of binder's board upon which is glued a second piece of the same size, from the centre of which a piece 10 by 3 in. has been cut. This then forms a tray about a line in depth, capable of holding ten slides. A third piece, from the centre of which a portion 10 by 1 in. has been removed, is hinged to the others so as to form a cover, the slot in its centre securing even deep cell preparations from pressure. The larger trays differ only in being of double size and holding twenty slides. Some of the trays have a fourth piece of lighter material, covering the slots in the top and thus rendering them complete dust-tight boxes. In series, however, this is unnecessary, as the covering of each tray is completed by the bottom of the one above. Each tray is, therefore, independent, a rubber strap about it rendering it entirely secure for holding or transporting specimens, while any number of them can be combined and further secured in a wooden case, making a neat and safe cabinet.

Such a cabinet, 12 in. by 9 in. by 10 in. in height, will contain a series of closed trays capable of holding 500 slides. Each tray must be withdrawn from beneath those above it in order to get at its

* Amer. Mon. Micr. Journ., iv. (1883) p. 64.

† 'The Microscope,' ii. (1882) pp. 134-5, from 'Western Medical Reporter.'

contents, and they must be lifted again in order to replace it; otherwise it is as convenient as any other form, while it has the great advantage that any one of its trays may be used at any time as an independent box; still further, its cost is about one-third of any comparable cabinet. The binder's board trays have, when first made, a little tendency to warp, and had better be kept under pressure, but this is only temporary.

Möller's Typen- and Probe-Platten.—The catalogue just issued by Mr. J. D. Möller contains a somewhat startling item—a "type plate" of 1600 arranged diatoms, the price of which is 1600 marks or 80*l.*! With 800 or 400 diatoms, 20*l.* and 3*l.* 15*s.* is asked.

Mr. Möller also issues type plates of 100 and 400 diatoms with the names of each photographed beneath.

All the type plates are mounted in monobromide of naphthaline.

Twenty-four test objects (diatoms) are now issued in eight different forms—viz. in air, balsam, monobromide of naphthaline, and phosphorus, and with cover-glasses of 0·16–0·20 mm. or 0·06–0·08 mm. These include *Amphipleura pellucida*, *Frustulia saxonica*, *Pleurosigma angulatum*, and *Surirella gemma*. The "Probe-platten" of 20 and 60 diatoms are also supplied in the four different forms of mounting.

Slack's Silica Films.*—Mr. H. J. Slack suggests an alternative mode of obtaining the silica deposit to that originally published. The old plan was to mix a teaspoonful of powdered fluor spar and rather less of powdered glass in a wide-mouthed 6-oz. bottle, pouring on it enough sulphuric acid to thoroughly wet it. Then place a loose moist tuft of cotton wool in the mouth of the bottle, put a paper cap over it to check evaporation and leave for some hours, when the cotton will be found to have a deposit of silica upon it like hoar frost. This deposit being scraped off into a watch-glass, and water poured softly on it and run off quickly, pure hydrate of silica is left in various curious shapes, some very much like portions of well-known diatoms. By the modified method, instead of allowing the silicic-fluoride gas to come into contact with wet cotton, some of it is passed through a mixture of four parts of glycerine and one of water. This is readily managed by using a very small flask or a tube bottle to contain the fluor spar, glass, and acid, and fitting to its mouth a few inches of bent glass tube. A gentle heat from a spirit-lamp causes the gas to be given off freely, and by dipping the tube just under the glycerine and water, which may be held in an egg-cup, silica films are instantly formed. The experimenter must be on the watch lest the tube gets stopped up with the silica deposit. As soon as it shows any signs of this, clear it out with a fine wire. Only a very small quantity is required of the various chemicals—a quarter or less of the quantities in the original experiment. The films should be washed, and then gently crushed and mounted, to be viewed with 1-4th and 1-8th in. objectives and dark-ground illumination. This is easily managed if the objectives

* Knowledge, iii. (1883) pp. 82–3.

are either old ones of small angular aperture or supplied with a movable stop to reduce their larger apertures when required.

Utility of the Microscope in Chemistry.*—In a paper by H. Reinsch on the detection and separation of certain minerals under the Microscope, it is claimed that the use of the Microscope in chemical analysis is not only rapidly increasing, but that it is approaching the spectroscope, and, in some respects, surpassing it in usefulness. It is admitted, however, that great skill is required in manipulation, and in preparing test objects to verify results, as appearances vary according to the degree of concentration of the solutions used, and different reactions will sometimes be obtained from the same salt. The following are some of the more interesting experiments:—

Silica, of all substances, yields the most varied and beautiful forms, resembling plants and ferns, often presenting, in the most glowing colours, five-leaved flower-forms in infinite varieties. To obtain these forms, we place a drop of a 4 per cent. solution of potassium silicate on an object slide, and then add a drop of a 2 per cent. solution of sodium bicarbonate, and then allow the liquid to evaporate at the ordinary temperature; after a few hours have elapsed the most beautiful flower-forms will be found spread over the slide, and will be readily recognized by a pocket lens, but when examined by the Microscope with the Nicol at 90°, will exhibit the crystals gleaming with a most magnificent play of colours. By moistening the object with a drop of copal varnish, and covering it with a thin glass, these forms may be permanently preserved. If we mix a drop of the 4 per cent. solution of the silica solution with a drop of the 1 per cent. sodium bicarbonate solution, we fail to obtain any plant-forms, but find polarized spheres, which, when the Nicol prism is at 90°, exhibit a dark cross, such as are obtained with calcspar; on further turning of the prism it seems to revolve visibly, and at 0° almost entirely disappears or passes over into a green cross. The most minute traces of silica can, by this means, be readily detected in a mineral, by melting a small sample of the substance with a little potassium hydrate, and dissolving it in a little water, and then placing a clear drop of the solution on an object slide in the manner previously indicated.

It is just as easy to microscopically determine *aluminium oxide* as it was to detect the silica. It may be recognized as well from its sulphates as from its alkali solutions. If we place a drop of a 4 per cent. solution on an object slide, and allow it to evaporate, spherical crystals will be obtained, which, turning at 90°, show a white cross formed of pencils of rays; if we cover the object with a mica plate, and place the Nicol at 0°, the rays of the little spheres appear as if composed of a number of small black grains; placing it at 60°, they appear as two blue rays opposite to each other, which at 90° assume a corresponding position, and on further turning of the prism dis-

* Cf. Journ. Chem. Soc., xlii., Abstracts (1882) p. 245, from Ber. Deutsch. Chem. Gesel., xiv. (1881) pp. 2325–31. Amer. Natural., xvi. (1882) pp. 614–8, from 'Scientific American,' Supplement 1.

appear entirely. If we mix a saturated aluminium oxide solution in potassium hydrate with sufficient water to produce a 2 per cent. solution, and place a drop or two of it on the slide, then mix the sample with a drop of a 1 per cent. solution of sodium bicarbonate, after evaporation there will remain a dull white spot, which, when still moist, shows peculiar spheres; by means of these alumina can easily and positively be distinguished from silica; for they appear when the prism is at 90° as a white cross whose diagonal axis ends in two round or rhombic scales. If we mix the alkali solution of silica and aluminium oxide with a drop of bicarbonate solution, the silica will appear as silvery, partly closed dendrites, while the alumina assumes lengthy forms which, when covered with a mica plate, seem blue, while the dendrites of silica are seldom coloured.

Glucina may be very easily distinguished microscopically from both of the preceding earths. A drop of a 4 per cent. solution of glucium sulphate, when evaporated on the slide, leaves large stars, which may be detected by the naked eye, whose fern-like leaves spread themselves over the entire surface of the drop. The star in the centre, when the prism is at 90°, exhibits prismatic colours, the leaves appear of a dull silver white or brownish colour, and they are often perforated.

Boric acid is likewise very easy to detect, for from its 2 per cent. aqueous solution there is obtained, after evaporation, a series of very small plates hardly 2 mm. in diameter, which, when they are magnified eighty times, do not show any cross. If the residue of the boric acid be moistened with a drop of the 2 per cent. solution of sodium bicarbonate, the dried drop will be found to consist of beautiful polarizing spheres, which in their centre enclose a small white cross; this, on turning the Nicol prism, also revolves. Occasionally dendritic stars instead of the spheres are formed.

The alkalies possess such optic properties that they can be definitely and certainly distinguished by the Microscope. In making these tests it is best to employ the sulphates for the examination, as they are the most constant in their composition, and in the drying the samples will not absorb moisture from the air, and so produce forms which may readily be recognized. Four per cent. solutions were made of the alkalies soluble in water.

The test with *potassium sulphate* gives, at 0° of the Nicol, a series of rhombic plates, which are not very well defined; at 90° blue rims with yellow or red spots are developed; these cannot be taken for any other alkali.

Sodium sulphate will be recognized as soon as it becomes dry by its precipitation. In the darker field of the Microscope it appears dull, and silvery-white in hopper-shaped quadratic crystals.

The *ammonium sulphate* assumes such peculiar shapes that it cannot be mistaken for any other salt. At 0° the crystals are hardly recognizable; at 90° they appear like partly decomposed walls built of grey blocks, with blue and brown rims.

Lithium sulphate forms clusters of prismatic needles which at 0° show beautiful colours and a blue cross, which at 90° becomes black.

The most minute quantities of lithia can be recognized by their optical behaviour.

Lime may be detected in several different ways; if a drop of a 2 per cent. solution of calcium chloride is mixed with a drop of a 1 per cent. sodium bicarbonate solution, the drop will become cloudy; and after drying it appears white and shows distinct dendritic stars, which consist of an accumulation of small crystals. Barium and strontium salts fail to show this reaction, or only in a very indistinct manner. Lime is best recognized under the Microscope when it is in the form of the sulphate, and is prepared by mixing a drop of the soluble lime salt with a drop of sodium sulphate. The sulphate crystallizes in stellar-shaped crystals, which cannot readily be mistaken for any other forms.

Barium nitrate assumes mossy, glistening like silver, colourless dendritic forms; while *strontium nitrate* takes the form of radiating needles, which are bluish at 0°, and at 90° are blue, green, and red.

Magnesia may, even when present in the most minute quantities, be detected by the Microscope. The *sulphate* forms colourless clusters of needles, which do not become coloured even at 90°.

The *copper sulphate* takes the form of step-like prisms, which at 0° are almost colourless, becoming at 70° light blue with green stripes, and at 90° show brilliant colours.

The 4 per cent. solution of *manganese sulphate* shows broad scales, silver white to grey in colour, and which are partly serrated at 0°, as well as at 60° and 90°. If the sample is left by itself for several days, polarizing spheres will appear; these are so peculiar that the manganese can readily be recognized from them, especially as no other metal forms such spheres.

Cadmium presents the most characteristic formation of all the metals; a 4 per cent. solution of the *sulphate* produces large spheres containing ellipsoids, which radiate from the centre, and are marked by regular transverse depressions. This formation can be recognized without a Nicol prism, and therefore it is not the result of the polarized light, but evidently depends upon the mechanical arrangement of the crystals. On using the Nicol the spheres show at 0° a beautiful blue or green cross, whose colour-zones increase with the turning of the prism until 90° is reached, when the most beautiful colours of the rainbow are manifested, while the ellipsoid becomes darker, better defined, and the transverse depressions are marked with dark spots. These phenomena become still more characteristic when observed over a plate of mica. From more dilute solutions of the cadmium sulphate, it is possible to obtain the spheres, but the peculiar structure is not observed.

If a 2 per cent. solution of *iron sulphate* be mixed with a 1 per cent. solution of sodium bicarbonate, the drop soon becomes cloudy, and is covered with a gold lustrous film of the oxide; after drying the specimen shows no spheres, but if it is allowed to remain quiet for two days, small crystals of iron *carbonate* are formed; these show the phenomena of polarization distinctly, but in a very peculiar manner.

Uranium sulphate assumes the most beautiful forms of all the metals; a 4 per cent. solution is used, and at least twelve hours are necessary to produce the desired formation. It can readily be recognized with a pocket lens, and resembles beautifully coloured asters or corn-flowers. Less frequently it occurs in the form of envelopes with velvet-blue, narrow, and purple-coloured broad triangles, which may also be recognized without the Nicol, and therefore are not produced by polarized light, but result from the mechanical arrangement of the crystals.

The *mercuric sulphate* is soluble with difficulty, but it can easily be brought into solution by the addition of a few drops of nitric acid. It forms figures similar in shape to a Maltese cross, of superimposed scales, which are very unstable.

Silver may easily be determined, and in such a way that it is not easily mistaken for any other metal. A drop of a 2 per cent. solution of silver *sulphate* deposits bright points which may be detected with the naked eye; at 0° these appear as complete rhombic octahedrons, with the edges cut off, at 90° they glisten with the most beautiful play of colours, like the diamond; at times groups are formed which seem exactly like a set of diamond jewellery.

Preparing Thin Slices of Rocks and Minerals.—Dr. A. Geikie, the Director-General of the Geological Survey of Great Britain and Ireland, in his 'Outlines of Field-Geology,' * deals with the advantages of microscopical investigation in the study of minerals and rocks, by which means we are enabled to trace the minuter structures of the earth's crust, and to follow many of the stages in the formation of its rocks. We can tell which mineral of a rock crystallized first, and, indeed, can follow every phase of crystallization in such a way as to explain many otherwise unknown parts of the history of the rocks. Moreover, by this method we can trace the subsequent changes which rocks have suffered in the chemical alteration of their minerals by percolating water, with the resulting secondary products. While a chemical analysis informs us of the ultimate chemical constitution of a rock, a microscopic analysis brings before us its mineralogical composition, showing in what forms the chemical elements have been combined, and how diverse two rocks may be in structure and texture, though in chemical composition nearly alike.

A cutting machine will greatly facilitate the process of preparing rock slices. The thickness of each slice must be mainly regulated by the nature of the rock, the rule being to make it as thin as can be conveniently cut, so as to save labour in grinding down afterwards. Perhaps the thickness of a shilling may be taken as a fair average. This thickness may be still further reduced by cutting and polishing a face of the specimen, cementing that on glass, and then cutting as close as possible to the cemented surface. The thin slice thus left on the glass can then be ground down with comparative ease.

Excellent rock sections, however, may be prepared without any

* 3rd ed. 1882 (Macmillan & Co.), pp. 30, 201–15. See also 'Text-Book of Geology' by the same author (Macmillan & Co.), 1882, pp. 94–108, 182–91 (figs.).

machine, provided the operator possesses ordinary neatness of hand and practice. A dexterous use of the hammer will break off from a sharp edge of the rock a number of thin splinters or chips about an inch square.

For the preparation of the thin slices for the Microscope, the following simple apparatus is all that is absolutely needful, though if a grinding machine is added it will save time and labour:—(1) A cast-iron plate 9 in. square and $\frac{1}{4}$ in. thick; (2) two pieces of plate-glass 9 in. square; (3) a Water-of-Ayr stone 6 in. × $2\frac{1}{2}$ in.; (4) coarse emery; (5) fine or flour emery; (6) putty powder; (7) Canada balsam; (8) a small forceps, and a common sewing needle in a wooden handle; (9) some oblong pieces of common flat window-glass 2 in. × 1 in.; (10) glass slides with ground edges; (11) thin cover-glasses; (12) a small bottle of spirits of wine. The following are the directions given by Dr. Geikie for the subsequent processes:—

"The first process consists in rubbing down and polishing one side of the chip or slice (if this has not already been done in cutting off a slice affixed to glass, as above mentioned). We place the chip upon the wheel of the grinding-machine, or, failing that, upon the iron plate, with a little coarse emery and water. If the chip is so shaped that it can be conveniently pressed by the finger against the plate, and kept there in regular horizontal movement, we may proceed at once to rub it down. If, however, we find a difficulty, from its small size or otherwise, in holding the chip, one side of it may be fastened to the end of a bobbin or other convenient bit of wood by means of a cement formed of three parts of rosin and one of beeswax, which is easily softened by heating. A little practice will show that a slow, equable motion with a certain steady pressure is most effectual in producing the desired flatness of surface. When all the roughnesses have been removed, which can be told after the chip has been dipped in water so as to remove the mud and emery, we place the specimen upon the square of plate-glass, and with flour-emery and water continue to rub it down until all the scratches caused by the coarse emery have been removed, and a smooth polished surface has been produced. Care should be taken to wash the chip entirely free of any grains of coarse emery before the polishing on glass is begun. It is desirable also to reserve the glass for polishing only. The emery gets finer and finer the longer it is used, so that by remaining on the plate it may be used many times in succession. Of course the glass itself is worn down, but by using alternately every portion of its surface, and on both sides, one plate may be made to last a considerable time. If after drying and examining it carefully we find the surface of the chip to be polished and free from scratches, we may advance to the next process. But it will often happen that the surface is still finely scratched. In this case we may place the chip upon the Water-of-Ayr stone, and with a little water gently rub it to and fro. It should be held quite flat. The Water-of-Ayr stone, too, should not be allowed to get worn into a hollow, but should be kept quite flat, otherwise we shall lose part of the chip. Some soft rocks, however, will not take an unscratched surface even with the Water-of-Ayr

stone. These may be finished with putty-powder, applied with a bit of woollen rag.

The desired flatness and polish having been secured, and all traces of scratches and dirt having been completely removed, we proceed to grind down the opposite side, and reduce the chip to the requisite degree of thinness. The first step at this stage is to cement the polished surface of the chip to one of the pieces of common glass. A thin piece of iron (a common shovel does quite well) is heated over a fire, or is placed between two supports over a gas-flame. On this plate must be laid the piece of glass to which the specimen is to be affixed, and the specimen itself. A little Canada balsam is dropped on the centre of the glass, and allowed to remain until it has acquired the necessary consistency. To test this condition, the point of a knife should be inserted into the balsam, and on being removed should be rapidly cooled by being pressed against some cold surface. If it soon becomes hard, it has been sufficiently heated. Care, however, must be observed not to let it remain too long on the hot plate, for it will then become brittle, and start from the glass at some future stage, or at least will break away from the edges of the chip, and leave them exposed to the risk of being frayed off. The heat should be kept as moderate as possible, for if it becomes too great it may injure some portions of the rock. Chlorite, for example, is rendered quite opaque if the heat is so great as to drive off its water.

When the balsam is found to be ready, the chip, which has been warmed on the same plate, is lifted with the forceps, and its polished side is laid gently down upon the balsam. It is well to let one end touch the balsam first, and then gradually to lower the other, as in this way the air is driven out. With the point of a knife the chip should be moved about a little, so as to expel any bubbles of air, and promote a firm cohesion between the glass and the stone. The glass is now removed with the forceps from the plate, and put upon the table, and a lead weight or any other small heavy object is placed upon the chip, so as to keep it pressed down until the balsam has cooled and hardened. If the operation has been successful, the slide ought to be ready for further treatment as soon as the balsam has become cold. If, however, the balsam is still soft, the glass must be again placed on the plate and gently heated, until on cooling the balsam resists the pressure of the finger-nail.

Having now produced a firm union of the chip and the glass, we proceed to rub down the remaining side of the stone with coarse emery on the iron plate as before. If the glass cannot be held in the hand, or moved by the simple pressure of the fingers, which usually suffices, it may be fastened to the end of the bobbin with the rosin cement as before. When the chip has thus been reduced until it is tolerably thin—until, for example, light begins to appear through it when held between the eye and the window—we may, as before, wash it clear of the coarse emery, and continue the reduction of it on the glass plate with fine emery. Crystalline rocks, such as granite, gneiss, diorite, dolerite, and modern lavas, can be reduced to the required thinness on

the glass. Softer rocks may require gentle treatment with the Water-of-Ayr stone.

The last parts of the process are the most delicate of all. We desire to make the section as thin as possible, and for that purpose continue rubbing until after one final attempt we perhaps find to our dismay that great part of the slice has disappeared. The utmost caution must consequently be used. The slide should be kept as flat as possible, and looked at frequently, that the first indications of disruption may be detected. The thinness desirable or attainable depends in great measure upon the nature of the rock. Transparent minerals need not be so much reduced as more opaque ones. Some minerals, indeed, remain absolutely opaque to the last, like pyrite, magnetite, and ilmenite.

The slide is now ready for the Microscope. It ought always to be examined with that instrument at this stage. We can thus see whether it is thin enough, and if any chemical tests are required they can readily be applied to the exposed surface of the slice. If the rock has proved to be very brittle, and we have only succeeded in procuring a thin slice after much labour and several failures, nothing further should be done with the preparation unless to cover it with glass, as will be immediately explained, which not only protects it, but adds to its transparency. But where the slice is not so fragile, and will bear removal from its original rough scratched piece of glass, it should be transferred to one of the glass slides (No. 10). For this purpose the preparation is once more placed on the warm iron plate, and close alongside of it is put the glass slide, which has been carefully cleaned, and on the middle of which a little Canada balsam has been dropped. The heat gradually loosens the cohesion of the slide, which is then very gently pushed along to the contiguous clean slip of glass. Considerable practice is needed in this part of the work, as the slice, being so thin, is apt to go to pieces in being transferred. A gentle inclination of the warm plate is advantageous, so that a tendency may be given to the slice to slip downwards of itself on to the clean glass. We must never attempt to lift the slice. All shiftings of its position should be performed with a point of a long needle or other sharp instrument. If it goes to pieces, we may yet be able to pilot the fragments to their resting-place on the balsam of the new glass, and the resulting slide may be sufficient for the required purpose.

When the slice has been safely conducted to the centre of the glass slip, we put a little Canada balsam over it, and allow it to be warmed as before. Then taking with the forceps one of the well-cleaned thin cover-glasses, we allow it gradually to rest upon the slice by letting down first one side, and then by degrees the whole. A few gentle circular movements of the cover-glass with the point of the needle or the forceps may be needed to insure the total disappearance of air-bubbles. When these do not appear, and when, as before, we find that the balsam has acquired the proper degree of consistence, the slide containing the slice is removed, and placed on the table with a small lead weight above it in the same way as already described. On becoming quite cold and hard the superabundant balsam round the

edge of the cover-glass may be scraped off with a knife, and any which still adheres to the glass may be removed with a little spirits of wine.

Small labels should be kept ready for affixing to the slides to mark the locality and reference number of the specimen. Thus labelled the slide may be put away for future study and comparison.

The whole process seems, perhaps, a little tedious; but in reality much of it is so mechanical, that after the mode of manipulation has been learnt by a little experience, the rubbing down may be done while the operator is reading. Thus in the evening, when enjoying a pleasant book after his day in the field, he may at the same time with some practice rub down his rock-chips, and thus get over the drudgery of the operation almost unconsciously.

One final remark may here be required. The learner must not suppose that, having prepared his slices, he has nothing to do but to place them under the Microscope, and at once determine the composition. He will find it by no means an easy task to make satisfactory progress, and at first he may be inclined to abandon microscopic work in despair of ever gaining confidence in it. Let him, however, begin by studying individual minerals, and make himself acquainted gradually with their various characters. He should procure numerous sections of minerals which enter into the composition of the rocks which he wishes to investigate. By degrees he will be able to discriminate them as they occur in the rocks, and once able to do this, his progress will be comparatively smooth. But he must be prepared for a long, patient course of training, and ought on no account to speak confidently about the microscopic structure of rocks until he feels assured that the confidence arises from sound knowledge."

Under the head of "The Microscope" the author explains the requirements of the field-geologist to be 1½ in., 1 in., and ½ in. objectives, giving powers from 30 to 300. It is always desirable to observe the characters of a rock as an opaque object; titaniferous iron, for example, appears by transmitted light in black structureless grains or opaque patches, whilst with reflected light the cleavage and lines of growth of the mineral can often be clearly seen, and what seemed to be uniform black patches are then found in many cases to inclose bright brassy kernels of pyrite. With transmitted light somewhat different appearances will be presented by two slices of the same rock, according to the thinness of the section, brown or almost black minerals appearing pale yellow, green, or almost colourless, when thinner. Dichroism and polarized light are also dealt with, and the author concludes with six questions which the student is to propound to himself for his satisfaction in the determination of rocks.

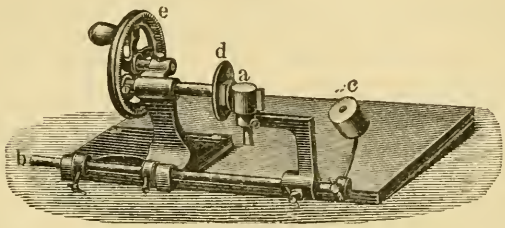
In his directions for preparing sections of fossil plants,* Dr. H. Conwentz describes two grinding and polishing machines made by Voigt and Hochgesang of Göttingen.

The first (fig. 88) is a hand-machine. The specimen is cemented

* In Behrens' 'Hilfsbuch zur Ausführung mikroskopischer Untersuchungen im Botanischen Laboratorium,' 1883 (Schwetschke u. Sohn, Braunschweig), pp. 162-73 (5 figs.).

to the carrier *a*, which is movable on the axis *b*, and can also be rotated in two directions. The object is pressed by the weight *c*

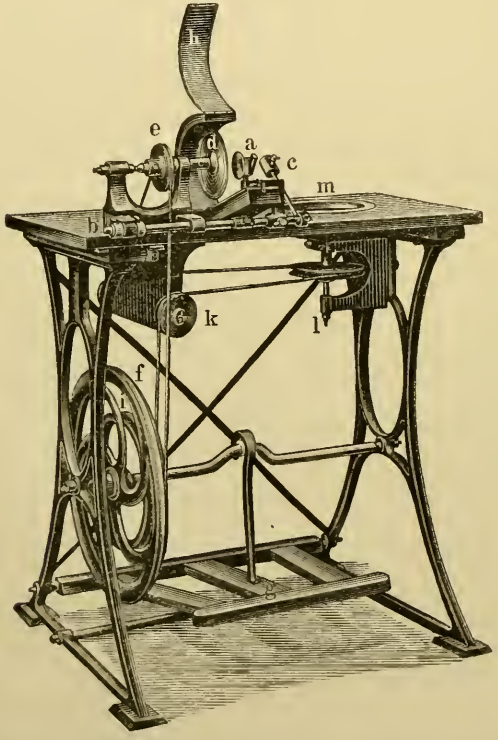
FIG. 88.



against the steel disk *d*, which is revolved by the wheel *e* acting on a smaller toothed wheel on the axis of *d*.

The second (fig. 89) is intended to be worked by the foot. The

FIG. 89.



parts *a*, *b*, *c* and *d* are the same as before. The wheel and treadle at *f* and *g* work the pulley *e*, by which the steel disk *d* is revolved; *h* is

part of the cover for the disk, to prevent the emery flying about. A box beneath also catches the powder that falls. (This arrangement is also supplied with fig. 88, though not shown in the woodcut.) A second wheel at *i*, with a cord passing over *k*, actuates a vertical spindle *l*, which rotates a horizontal cast-iron plate at *m* for polishing.

Making Sections of Rock, Bone, Ivory, &c.*—Mr. J. Smith describes the following method of making and mounting transparent rock-sections. The first step is, of course, to get a suitable piece of rock, say a fragment of trap or basalt. This should be broken as thin as possible, and to do this, having struck off a fragment from the parent rock or boulder, take it between the fingers and thumb of the left hand. Hold one edge on the rock from which it was struck, or any hard stone which may be convenient, and strike it a sharp blow with the hammer fair on the opposite edge. If this is well done thin fragments about 1-8th in. thick will fly off.

The fragments of rock should be roughly clipped in the field by wire nippers into disks of about 7-8ths in. diameter, and having reached home the next thing is to make the disks roughly circular, and to flatten and polish one side. To do this, a flat slab of polished sandstone, 18 in. square by 4 in. thick, is used, on which the edge of the disk is rubbed, using water and giving it a slight turn at every rub; a very little practice will enable any one to make the disks almost circular. But what is chiefly to be aimed at in making them circular is to get a smooth edge, as a disk having a perfectly smooth edge will not break so readily in the subsequent process as a rough-edged one. It should now measure about 5-8ths of an inch in diameter. The flat face must next be polished so as to remove every trace of scratching caused by the sandstone, and it is necessary at the same time to make this face perfectly flat. To accomplish this, a water-of-Ayr hone, 7 in. square by 2½ in. thick, is used, having one of the faces perfectly flat. On this face the disk is rubbed with water, until it also becomes perfectly flat and free from scratches. It must then be made thoroughly clean and mounted on a piece of hard wood (well seasoned beech wood) 2 in. square by ¾ in. thick. The disk is fixed to the block with gum arabic, putting plenty round the sides, so as to form a collar, and allowed to harden for two or three days.

The specimen is now to be ground down until the beech can be seen distinctly through it. It will not do to rub it on the sandstone now, as water would dissolve the gum, and the specimen would be at once detached. For the purpose of rubbing it down use a flat metal plate, coarse emery powder, and paraffin, turpentine, or benzoline, as none of these substances will dissolve gum arabic. After it has been reduced to about 1-20th in., more speed may be obtained by using a Turkish whetstone sprinkled with a little of the finest emery powder, rubbing on this till the wood may be *dimly* seen through the specimen. At this stage, the specimen, wood, and whetstone are cleaned with a piece of rag soaked in turpentine, and rubbed down on the bare stone, using the same fluid, till the specimen is thin enough to be taken off

* Journ. Post. Micr. Soc., ii. (1883) pp. 28–33 (2 figs.).

the wood. This is the most critical period in the rubbing process, which must be done very gently.

In making sections of flints, agates, and stones of like hardness, it is of no use rubbing them on the sandstone; they must be ground down from the very first on the iron plates with emery. The rest of the process is the same as above.

When the beech can be well seen through the specimen, a few light rubs should be given on the water-of-Ayr stone, using water. The specimen is then ready to be mounted in Canada balsam.

Remove with a wet cloth all the gum from the edge of the specimen, and thoroughly clean the wood of all impurity. Boil the kettle. Stick the blade of a pen-knife into the side of the beech, to act as a handle, and hold the specimen in the steam from the kettle-spout till it slides down the face of the wood. There need be no fear of its falling off. The water from the steam will prevent this. It may come off in less than five minutes, or it may take half an hour. It is useless to try to hasten the process, by pushing the specimen with the edge of the knife-blade; this will only end in a vexatious smash. After all, on an average, about a dozen specimens can be "steamed" from the wood and mounted in balsam in about two hours. With every care, a specimen will sometimes break in two or more pieces, in which case a slide may perhaps be made of each fragment. The specimen having at last become loose on the wood, heat a glass slide over an argand burner, and with the blade of a penknife move the specimen gently to the edge of the wood. Put the knife-blade under the edge that projects beyond the wood, steadying the hand on the side of the wood, and not attempting to lift the section, but drawing it off the wood gently; the water from the condensed steam will keep it attached to the knife. Put a drop or two of warm balsam on the heated slide, have ready a slide template covered with paper, having a circular hole cut in the middle of it, 5-8ths in. in diameter, or the same size as the specimen. Put the template under the heated slide, holding both in the left hand. Dry the free side of the specimen (still on the knife) over the argand lamp. Place the specimen gently on the balsam, directly over the hole in the template. Draw the knife off sideways. If it is attempted to lift it up, the specimen will break in pieces, the water holds the section so firmly to the knife. Heat a 3-4ths in. glass cover over the argand lamp, and put two drops of balsam on it; lay it gently on the specimen, which by this time should be perfectly flat; do not squeeze; heat the template, slide, and section over the lamp, and let the balsam gently boil, to expel the air-bubbles. Again, do not squeeze, but keep the object in position over the template with the point of the knife-blade. Allow the slide to cool a little; now gently squeeze down the glass slip so as to expel all superfluous balsam.

Mr. Smith says that the process is also suitable for making transparent sections of bone, ivory, &c., and is much superior to the old method of rubbing down a specimen fixed with balsam to a glass slip.

Babes, V.—Ueber einige Färbungsmethoden, besonders für krankhafte Gewebe mittelst Safranin und deren Resultate. (On some staining methods especially for diseased tissue, with Safranin, and their results.) [*Post.*]
Arch. f. Mikr. Anat., XXII. (1883) pp. 356–65.

Balfour, F. M. See Foster, M.

Barré, P.—Sur l'alignement des Diatomées dans les préparations. (On the arrangement of diatoms in preparations.) [*Supra*, p. 452.]
Bull. Soc. Belg. Micr., IX. (1883) pp. 74, 75–7.

Bayles, J. C.—Microscopic Analysis of the structure of Iron and Steel. [*Post.*]
Science, I. (1883) p. 101.

Bedriaga, J. v.—Eine neue Kittmasse zum Verschliessen der Cylinder und Büchsen. (A new cement for sealing cylinders and boxes.)
[Hofmann's "White Universal Cement."]
Zool. Anzeig., VI. (1883) pp. 229–30.

Bennett, R. A. R.—Mounting legs, &c., of Insects.
[Contains the following:—"The chief difficulty is the appearance of air-bubbles in the object after it has been mounted. To avoid this, there is a little dodge not mentioned in most books. When the leg is taken out of the turpentine, instead of placing it at once on the slide, boil it for a few moments in some balsam, kept for the purpose in another tube. While it is being boiled the air will escape, and the balsam will take its place. There will, therefore, be not nearly so much chance of air-bubbles arising when the object is mounted. Of course, this would be rather rough treatment for some objects; but with the legs of insects (especially such as *Dytiscus marginalis*) it generally answers admirably, and saves a vast deal of trouble."]
Engl. Mech., XXXVII. (1883) p. 253.

Berthold, G.
[Description of a method for preparing marine algæ, *supra*, p. 451.]
Jahrb. f. Wiss. Bot., XIII. (1882) pp. 704–5.
Abstr. by Dr. C. O. Whitman in *Amer. Natural.*, XVII. (1883) pp. 456–7.

C., T.—Reply to M. A. B. (*ante*, p. 309) as to Breakage of Slides in the Mail.
[Uses wooden boxes and wraps tissue paper round the slide several times until it fits very tight into the grooves in the box, so tight that the slides have to be forced in with some pressure.]
Amer. Mon. Micr. Journ., IV. (1883) p. 78.

Carbolic Acid Process.
[Note as to the process having been originated by Dr. Ralph in 1874, and the balsam and chloroform mixture in 1857.]
Southern Science Record, III. (1883) p. 31.

Chadwick's (H. C.) use of alcohol for mounting *Lophopus crystallinus* with the tentacles expanded.
[The spirit is blown as a spray upon the surface of the water containing the organisms; it mixes slowly, and the tentacles are thereby not retracted.]
Micr. News, III. (1883) p. 150.

Cole, A. C., Studies in Microscopical Science.
No. 48 (pp. 293–8). Porphyritic Basalt. Arthur's Seat, Edinburgh. Plate × 25.
No. 49 (pp. 299–302). The Alimentary Canal. The Small Intestine. Explanation of plate to accompany No. 51.
No. 50 (pp. 303–4). Serpentine.—The Lizard Serpentine. Plate × 25 with No. 52.
No. 51 (pp. 305–12). The Alimentary Canal. The Large Intestine. Two plates of T. S. Large Intestine (slide) and Duodenum of Dog × 25.
No. 52 (pp. 313–8). Serpentine. Portsoy, Scotland. Plate × 25. Also Plate (× 25) of Serpentine between Kynance Cove and Lizard Town, Cornwall.

Fawcett, J. E.—Mounting with Wax-cells. [*Post.*]
Micr. News, III. (1883) pp. 153–4.

Fehleisen.—Ueber neue Methoden der Untersuchung und Cultur pathogener Bacterien. (On new methods for the investigation and culture of pathogenous Bacteria.) [*Post.*]

SB. Phys.-Med. Gesell. Würzburg, 1882, pp. 113–21.

Foster, M., F. M. Balfour, A. Sedgwick, and W. Heape.—The Elements of Embryology. 2nd ed., xiv. and 486 pp., 141 figs. 8vo, London, 1883.

[Pp. 423–71 consist of an Appendix containing "practical instructions for studying the development of the chick," and "practical directions for obtaining and studying mammalian embryos."]

[Geinitz, E.]—Hunting for lost glaciers with a Microscope.

[Review of the author's paper in *Nova Acta Acad. Leop.-Carol.*, XLV. p. 35.]

Science, I. (1883) p. 177.

Griesbach, H.—Beiträge zur Verwendung von Anilinfarbstoffen in der Microscopischen Technik. (Contributions to the use of aniline staining substances in microscopical technics.) [*Supra*, p. 446.]

Zool. Anzeig., VI. (1883) pp. 172–4.

Hanaman, C. E.—Improved Filtering Reagent Bottle.

[A wide-mouth bottle with three glass tubes through the cork. The delivery tube reaches nearly to the bottom of the bottle and is curved above the cork. Just beyond the curve this tube is attached to a larger tube filled with absorbent cotton forming a filter, and to the lower end of which is a short piece of tubing contracted at its distal end. Another of the three tubes has a "thistle-bulb" top to readily introduce the reagent from dishes, &c.

Amer. Mon. Micr. Journ., IV. (1883) pp. 41–3 (1 fig.).

Harris, V.—On double staining Nucleated Blood-corpuscles with Anilin Dyes. [*Supra*, p. 447.]

Quart. Journ. Micr. Sci., XXIII. (1883) pp. 292–301.

Heape, W. See Foster, M.

Hertwig's method of preparing and cutting Amphibian Eggs. [*Supra*, p. 442.]

Amer. Natural., XVII. (1883) pp. 572–4,
from *Jen. Zeitschr. f. Naturwiss.*, IX. (1882) p. 249.

Hitchcock, R.

["It may interest some readers, especially those who are studying the diatoms, and would like to find the rare forms that occur occasionally in the stomachs of certain animals, to know that the contents of an oyster's stomach can be withdrawn by inserting a tube through the mouth. If this can be done with the oyster there is no apparent reason why it cannot also be done with many other animals, and the contents could be far more easily cleaned than when they are obtained by dissection in the usual way."]

Amer. Mon. Micr. Journ., IV. (1883) p. 77.

Instrucçoes para a colheita e preparação de productos botanicos. (Instructions for the collection and preparation of botanical products.)

Soc. Brotcriana, Bol. Annual., I. (1880–2) [Coimbra, 1883] pp. 5–20.

Jackson, E. E.—Crystals of Sodium Chloride.

[Method of exhibiting under a low power by mixing on a slide a little solution of salt and alcohol.]

The Microscope, III. (1883) p. 5.

" " The Microscope in Medicine.

["Notes from my record of microscopic work . . . . to illustrate the value of the instrument in correct diagnosis." Pea in the ear. Urine.]

The Microscope, III. (1883) p. 16.

Kingsley, J. S.—Imbedding. [*Supra*, p. 444.]

Sci. and Lit. Gossip, see *Amer. Mon. Micr. Journ.*, IV. (1883) p. 58.

Lockwood, S.—Labelling Slides. [*Supra*, p. 456.]

Amer. Mon. Micr. Journ., IV. (1883) p. 64.

Molisch, H.—Ueber den mikrochemischen Nachweis von Nitraten und Nitriten in der Pflanze mittelst Diphenylamin oder Brucin. (On the microchemical analysis of nitrates and nitrites in plants by means of diphenylamin or brucin.) *Ber. Deutsch. Bot. Gesell.*, I. (1883) pp. 150–5.

REINSCH'S (P. F.) Preparations of Coal. [*Post.*]
Bull. Soc. Belg. Micr., IX. (1883) pp. 87–8.

RICHARDSON, B. W.—Sections to illustrate multiple staining. [Exhibition.]
Ann. & Mag. Nat. Hist., XI. (1883) p. 282.

S., J. C.—Pond-life in Winter.
[Description of the Rotifers, Infusoria, &c., found in a dipping through a hole cut in the 10-in. thick ice of a pond.]
Amer. Mon. Micr. Journ., IV. (1883) pp. 62–3.

SEDGWICK, A. See Foster, M.

SLACK, H. J.—Pleasant Hours with the Microscope.
[Examination of aphides and cells for same. *Post.*]
Knowledge, III. (1883) pp. 219–20, 245–6, 288.

VAN BRUNT, C.—Preparation of *Bacillaria paradoxa*.
[Exhibition of a preparation showing the frustules burnt upon a cover-glass, maintaining their position just as in life. This was made by adding alcohol to the water containing the diatoms. They were suddenly killed and did not separate.]
Amer. Mon. Micr. Journ., IV. (1883) p. 60.

WHITMAN, C. O.—Note on Blanc's method of preserving and staining Protozoa. [*Ante*, p. 293.]
Amer. Natural., XVII. (1883) p. 458.

ZIETZ, A.—Mittheilungen betreffend Aufstellung und Behandlung von Alcohol-präparaten. (Communications on the putting up and treatment of alcohol preparations.)
[Additions to Dr. K. Möbius' communication, *ante*, p. 292.]
Zool. Anzeig., VI. (1883) pp. 199–200.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 11TH APRIL, 1883, AT KING'S COLLEGE, STRAND, W.C., CHAS. STEWART, ESQ., M.R.C.S., F.L.S. (VICE-PRESIDENT), IN THE CHAIR.

The Minutes of the meeting of 14th March 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
Gerard, J.—A Catalogue of Plants (1596). Edited, with notes, &c., and a life of the author, by B. D. Jackson. xvi., v., and 64 pp. (Privately printed. 4to, London, 1876.)	
Lamouroux, J. V. F.—Histoire des Polypiers Coralligènes flexibles, vulgairement nommés Zoophytes. lxxxiv. and 559 pp. 19 pls. (8vo, Caen, 1816.)	
Turner, W.—Libellus de re herbaria novus (1538). Reprinted in facsimile, with notes, &c., and a life of the author, by B. D. Jackson. xii., xviii., 20, and 8 pp. (Privately printed. 4to, London, 1877)	*Mr. Crisp.*
Spallanzani, L.—Tracts on the Natural History of Animals and Vegetables. Translated by J. G. Dalyell. 2nd ed. 2 vols. (8vo, Edinburgh, 1803)	*Mr. G. J. Smith.*
24 Slides of Diatomaceæ and Fresh-water Sponges	*Mr. B. W. Thomas.*
Desiccated Rotifers	*Rev. E. J. Holloway.*

Mr. Crisp exhibited and described Bertrand's, Fuess's, and Nachet's Petrological Microscopes; also Rollett's Polari-Spectro-Microscope.

Dr. Maddox exhibited and described a double aëroscope, with small aspirator for the collection of germ cells from the atmosphere. A diagram of the apparatus was also shown in illustration of the construction and connections of the various parts (*supra*, p. 338).

The Chairman was sure the Fellows would feel greatly obliged to Dr. Maddox for bringing this interesting instrument and showing it to them in action, and thought the instrument would undoubtedly be very useful if extensively used for the examination of atmospheric germs in hospitals or places where infection was suspected.

Mr. Crisp called attention to the views of MM. Prinz and Van Ermengem as to the markings of diatoms (*supra*, p. 411), and to the paper by Dr. Hogg on the movements of diatoms (*ante*, p. 262).

Mr. Michael said it would be interesting to know how these sections were obtained, whether by grinding or by any other means.

Mr. Wilson understood that the sections of the rock were ground down in the usual way; and, this being done, the calcite was dissolved out, so as to leave the section of the diatom free.

Messrs. Malcolm Morris and G. C. Henderson's paper, "On the Life-history of the Ringworm Fungus," was read by the Secretary, photomicrographs in illustration being handed round for examination (*supra*, p. 329).

The Chairman was sure that all would agree that this paper was one of considerable interest, as indeed was always the case whenever a disease could be traced to its source. It had, however, yet to be seen whether this was a variety of some known species of *Penicillium*, or whether it was some specific form; but whichever it might prove to be, it was very satisfactory to find that it had been so clearly traced as the producer of the ringworm disease.

Dr. Maddox said it had given him much pleasure to follow up all these experiments independently, and he could say that he had confirmed them all. It was very curious and interesting to watch the growth of these forms, which he could be sure that he had never seen figured anywhere before. He had not ventured to try the incubating process, but found that the growth took place at the ordinary temperature of a room, only under these conditions it went on more slowly. He thought they might take it as being really proved that this fungus was the cause of the disease, but whether or not it was a distinct form he was unable to say. The bearing of a subject of this kind upon the apparatus which he had exhibited was obvious: it might readily be used in a large schoolroom where ringworm was prevalent, and, by catching the germs, might prove that they were carried about in the air from child to child.

Mr. Morris, in reply to an invitation from the Chairman, said he merely wished to point out that all previous observers who had used fluid had met with the difficulty that other germs and fungi got mingled with it. What was claimed for their procedure was that in using gelatine-peptone the growth went on in the substance of the jelly, so that it was quite possible to mark down a particular spore and watch it from day to day. They had noted that the fructification did not take place until the jelly had dried down to a certain degree. The fungus might possibly be a variety of *Penicillium*, but they had tried to produce the thing backwards with *Penicillium* and had failed, as all previous observers had done. It had been believed that this fungus belonged to a separate group, and that it was a *Mucor*.

Mr. C. G. Matthews's paper, "On the Red Mould of Barley," was read by Mr. Cowan, the subject being illustrated by numerous diagrams (*supra*, p. 321).

Mr. Bennett thought the paper was an extremely interesting one. He remembered that there was a notice about two years ago in the Bulletin of the French Botanical Society on red grains of corn: he believed wheat was referred to. The cause of the red colour was in

that case attributed to micrococci. It was interesting to find that in the case of the barley detailed in the paper that evening the colour was due to a fungus of a higher character than the micrococcus.

The Rev. E. J. Holloway's letter was read, accompanying some dried mud from the rain-water spouting of the church, which when moistened showed a large number of *orange* coloured rotifers. The colour, Mr. Holloway thought, might be due to lichen spores, which fall into the gutter from the roof, and which can be seen in the dried deposit.

The Chairman said it would be interesting to examine whether the orange colour was really in the tissues of the animals, or was accidental, from their having taken in some colouring matter as Mr. Holloway suggested.

Mr. B. W. Thomas's letter was read in reference to 24 slides of Diatomaceæ and spicules and statoblasts of fresh-water sponges which he sent. Amongst the former were *S. Niagaræ* from the Niagara river, and *P. delicatulum*, not marine, but from fresh water.

The Conversazione was announced for the 2nd May.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—(1) Bertrand's, (2) Fuess's, and (3) Nachet's Petrological Microscopes, (4) Rollett's Polari-Spectro-Microscope.

Rev. E. J. Holloway:—Rotifers in dried mud.

Dr. Maddox:—Double Aëroscope.

Mr. C. G. Matthews:—Specimens in illustration of his paper on the Red Mould of Barley.

Messrs. M. Morris and G. C. Henderson:—Photomicrographs of Ringworm Fungus.

Mr. B. W. Thomas:—Diatomaceæ and Spicules and Statoblasts of Fresh-water Sponges.

Mr. J. W. Reed:—Non-calcareous cystoliths in the Medullary parenchyma of *Goldfussia isophylla* and calcareous cystoliths in cortex of same (*ante*, p. 95).

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. E. R. Blundstone, F. R. Flintan, C. F. Holland, and D. S. Kellicott, B.S., Ph.D.; and as *Ex-officio* Fellow, the President for the time being of the American Society of Microscopists.

Conversazione.

The following is a list of the objects, &c., exhibited at the Conversazione on the 2nd of May, 1883 :—

Mr. Baker:
Slides illustrating the Embryology of Marine Crustacea, Fishes, &c. By Sinel & Co., of Jersey.

Messrs. R. and J. Beck:
Spirillum, showing jointed structure; striated muscle; and membrane from eye of cat.

Mr. Cocks:
Ova of perch, and *Conochilus volvox*.

Mr. Curties:
Diatoms from Hong Kong.

Mr. F. Enock:
Apis mellifica, showing pollen-basket.

Mr. James Fleming:
Volvox globator, showing the hatching of *Notommata parasita* in the interior.

Mr. A. de Souza Guimaraens:
Fungus spores and mycelium from Halifax coal strata.

Mr. H. F. Hailes:
Foraminifera from Teneriffe.

Mr. J. E. Ingpen:
Steinheil's Micrometer Eye-pieces (solid and achromatic), 1½, 1, and ½ in.

Mr. W. Joshua:
Stigonema mamillosum (Ag.) from a bank of Lake Ogwen, near Capel Curig, N. Wales; and *Bostrychia sertularia* (Mont.) from Bermuda.

Dr. Maddox:
Aëroscope and Aspirator combined for collecting floating matters in the air.

Mr. A. D. Michael:
Reproductive organs of *Damæus geniculatus*.

Dr. Millar:
Tetrarhynx from stomach of cod.

Mr. F. W. Millet:
A selection of Foraminifera.

Mr. E. M. Nelson:
Podura.—Polarized light. Zeiss water-immersion 1-25th N.A. 1·1. Magnification 2500 diameters.
Pleurosigma Fasciola.—Powell and Lealand's Oil-immersion 1-25th N.A. 1·38. Direct light achromatic condenser. Magnification 2500 diameters.
New Model of Stand. By Messrs. Swift and Son.

Messrs. Powell and Lealand:
Podura, *Amphipleura pellucida*, &c., with 1-25th Oil-immersion N.A. 1·38 and Achromatic Condenser.

Mr. B. W. Priest:
Statoblasts of Fresh-water Sponge, showing tubes and processes.
Mr. J. W. Reed:
Spicular cells in cortical portion of stem of *Araucaria Bidwillii* and *A. excelsa*.
Mr. S. O. Ridley:
Chætopodous annelid.
Mr. G. Smith:
Nephiline dolerite, pitchstone, &c.
Messrs. Swift and Son:
Eggs of parasite of goose.
Mr. W. A. Thoms.
Potato disease: sclerotia of *Peronospora infestans*, as seen on the under side of mature leaf of potato, both ungerminated and germinated.
Mr. A. Topping:
Larva of bot-fly, pupa of black ant in the cocoon, &c.
Mr. H. Waddington:
Melicerta ringens and *Stentor*.

Meeting of 9th May, 1883, at King's College, Strand, W.C.
Dr. R. Braithwaite, F.L.S. (Vice-President), in the Chair.

The Minutes of the meeting of 11th April last were read and confirmed, and were signed by the Chairman.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Dodel-Port, A. & C.—Anatomisch-physiologischer Atlas der Botanik. Part 7	*The Authors.*
Cobbold, T. S.—The Internal Parasites of our Domesticated Animals. iv. and 144 pp., 28 figs. (8vo, London, 1873.)	
Gray, H.—Anatomy, Descriptive and Surgical. 5th ed. by T. Holmes. cxxx. and 768 pp., 395 figs. (8vo, London, 1869)	*Mr. Crisp.*
Micrographic Dictionary. 4th ed., Parts xvi.–xxi.	*Mr. Van Voorst.*

The Chairman said they were favoured that evening by the presence of Mr. Romyn Hitchcock, of New York, and he invited that gentleman to address the meeting.

Mr. Hitchcock said he regretted that he did not know in time that he was coming to England, or he would have brought some instruments for exhibition. Taking, however, just what he had in hand, he would exhibit two pieces of apparatus which he thought might be of interest. The first was Grunow's camera lucida, and the other a detaching nose-piece (Pease's "Facility" nose-piece) for rapidly

fixing and removing objectives from the Microscope (*supra*, pp. 423 and 425). The latter was made upon the principle of the self-acting chuck, there being three lateral jaws which were forced inwards as the collar was turned. On each objective a ring was fixed in which was a small groove, by means of which the attachment was made with great facility. He had not yet had the opportunity of comparing this appliance with others devised for similar purposes, but he knew that it had been in the hands of a gentleman who was a very expert manipulator, who said that it did all that was claimed for it. He had also brought with him three objectives of American manufacture, which might be of interest: one of these was a 1-6th in. dry objective by Spencer; another was a 1-15th in. immersion, also by Spencer; and the third was a combination by Gundlach: it was a 1½ in., but could be converted into a 3 in. by simply removing the front lens.

Mr. Ingpen asked if the camera lucida by Grunow was claimed to be new, or simply a convenient application of earlier methods. M. Nachet, some years ago, produced a camera on the same reflecting principle, but in which he used a film of gold so thin that it not only reflected the drawing, but also allowed sufficient light to pass through it to enable the object to be viewed. The plan was one which appeared to work very well, the only disadvantage being that the object had to be seen through a very thick piece of glass which in some cases caused distortion of parts of the image. With regard to the nose-piece, it seemed to him to work well, but it should be noted that it would be necessary to have every objective intended to be used with it, fitted with one of the grooved collars. Whether or not it would prove better in practice then Mr. Nelson's nose-piece, could only be determined by practical use.

Mr. Curtis said that the "Facility" nose-piece appeared to be an admirable contrivance, and one which certainly answered to its name. Its action was perfect, provided care was taken to cut the ring accurately.

Mr. Hitchcock said, so far as Mr. Grunow was concerned, his camera lucida was a perfectly original idea, but it was possible that he had not the facilities for knowing what had been done elsewhere. Indeed it would seem a little strange if so simple a contrivance had not been thought of before. The rings were cut inside to the Society's screw, so that any objective would fit them, and it was the practice to send out four rings with each nose-piece. Of course if a person had more than four objectives, he had only to order additional rings for them.

Dr. Anthony said that the weak point of Nachet's camera lucida was that the image of the pencil could not be seen equally well over the entire field, and that it became entirely lost towards the outer side, or that which was farthest from the body of the instrument. He would like to ask, therefore, if in this new arrangement the point of the pencil could be more clearly seen.

Mr. Crisp understood that it was claimed the pencil could be seen with exceptional distinctness.

Mr. Mayall drew upon the blackboard diagrams showing the con-

struction of the three forms of instrument under discussion—(1) Nachet's, (2) Abbe-Zeiss's, (3) Grunow's.

The Chairman thought that the variety of these instruments showed that there had been considerable difficulty met with in endeavouring to obtain good results. His own experience was that it was better to keep to one form, and by constant use to acquire facility in its manipulation.

Mr. Crisp said one way which had been suggested for getting over the difficulty of seeing the pencil was to draw on black paper with a white bone pointer, the under surface of the black paper being also blackened, and transferring the marks made upon its upper side to a sheet of white paper underneath.

Mr. Hitchcock, in reply to some remarks by Mr. Ingpen as to the difficulty of seeing both the object and the pencil point at the same time, said he thought that the most perfect form of camera was one in which the pupil of the eye was divided, because when they had objects to deal with in which there was a great contrast between the light from various portions, there would be some parts where the pencil would be seen with great clearness under any conditions, but when, in other portions, the light became stronger and the pencil point consequently dimmed, all they had to do was to move the pupil over the edge sufficiently to equalize the light according to the requirements of the altered conditions.

Mr. Stewart was under the impression that any shifting of the position of the pupil would be likely to involve an apparent shifting of the image, which would be an inconvenience.

Mr. Michael said he had a good deal of experience in this matter, and had always found that if the pupil was moved the image did certainly shift; but he had got over all practical difficulty by using two lamps, one to illuminate the object in the usual way, and the other—the more powerful of the two—to illuminate the paper, and in this manner, with a very little trouble, the apparatus could be so arranged that neither the light on the object nor that on the pencil would overbalance one another.

Mr. Coppock exhibited a new and cheap form of Microtome, devised by Mr. Cathcart, for freezing by means of ether spray, by means of which a gum solution or paraffin can be frozen in one minute with a consumption of 1-16th oz. of methylated sulphuric ether.

Mr. Groves thought it a very nice instrument for the purpose, the chief objection to it being that the vapour of the ether was discharged into the room.

Mr. Watson exhibited and described a new form of Microscope with swinging substage, the pattern having been suggested by Mr. Bulloch's Biological Microscope.

Mr. Crisp called attention to another novelty, which for obvious reasons was not exhibited that evening, viz. a type slide of diatoms by J. D. Möller, containing 1600 species, the price of which was 1600 marks, or 80*l*. Möller's type slides, he might add, were now to be had mounted in four different media, including phosphorus and monobromide of naphthaline.

Dr. Braidwood read his paper "On Observations on Three Human Contagia," the subject being illustrated by specimens exhibited under the Microscope.

The Chairman expressed the pleasure with which he had listened to this very interesting paper upon a subject of so much importance, the area of which seemed widening every day.

Dr. Maddox said it would, in connection with this subject, be interesting to know that the Aëroscope, which he had the pleasure of exhibiting at the last meeting of the Society, was an instrument specially designed for carrying out observations such as those described in the paper. There could be no doubt that the subject covered a very wide area, so great indeed as to be beyond the compass of any private individuals, so that the subject was one which, owing to its great importance, he thought should be worked out with the assistance of the Government. This was how it was being investigated in Paris, with very remarkable results. He held in his hand, and would submit for examination, a most interesting diagram, which had been prepared from the consideration of some 80,000 experiments at Paris, and which showed that the atmosphere, though laden with these germs, was not homogeneously so. There were many more at some periods than at others, and it was found that rainfall diminished the number very considerably. They needed, however, all the information it was possible to obtain, and a large amount of careful observation would be necessary before they could arrive at any definite conclusions. At present they were unable to say that the death-rate was sensibly affected by the quantity found.

Dr. Anthony inquired if there was any great difficulty in staining the specimens with Vesuvian brown? All that really appeared to be necessary was to stain with something which would affect the germs more than the surrounding medium. As described in the paper, it would seem to be a very simple thing to repeat the experiments and to verify them. He might mention, as a practical point to be noted, that all these zymotic diseases became much more infectious towards the conclusion of their course, and that they were far more so after the patient was up and apparently recovered than when he was down and lying in bed, and that it was when the disease was passing away that it was really the most contagious.

Dr. Braidwood, in reply, said that, with regard to the staining, the process was quite simple, and was arranged so as to involve as little manipulation as possible. The drop of albumen was dried gently over the spirit-lamp with great care, and the slide was then laid with

the film downwards in a watch-glass containing the stain, the excess of staining being afterwards discharged by simple washing. With regard to the development of these germs into higher forms of life, he had no practical experience, except in the case of measles, in which, as already described, the two forms were seen, the rod-shaped forms appearing on the fourth day. In the case of chicken-pox, he had not been able to make this out, as he had not been able to trace the subject out so well as he could have wished by continuing his observations from day to day.

Dr. Beale's drawings of organisms from Thames mud were exhibited.

Mr. C. J. Muller's note on the decomposition of *Synedra radians* by caustic potash was read (*supra*, p. 409).

The following Instruments, Objects, &c., were exhibited:—

Dr. Beale:—Drawings of organisms from Thames mud.

Mr. Bolton:—Spawn of perch (?)

Dr. Braidwood:—Three slides to illustrate his paper. (Section of skin showing the Bacilli of Measles; Fluid from the vesicles of Varicella—chicken-pox; &c.)

Mr. Coppock:—Cathcart's Ether-spray Freezing Microtome.

Mr. Crisp:—Klönne and Müller's "Pendulum" Stage and Microscope.

Mr. Hitchcock:—(1) Grunow's Camera Lucida. (2) Pease's "Facility" Nose-piece.

Mr. Watson:—New Microscope.

New Fellows.—Messrs. E. T. Bastin, Thomas J. Burrill, A.M., Ph.D., Lester Curtis, M.D., Henry J. Detmers, Edward D. Gravill, Walter Townend, A. G. Warner, and James Whitson, M.D.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY,

Containing its Transactions and Proceedings,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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

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

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

A. W. BENNETT, M.A., B.Sc., Lecturer on Botany at St. Thomas's Hospital, | F. JEFFREY BELL, M.A., Professor of Comparative Anatomy in King's College,

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

FELLOWS OF THE SOCIETY.

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

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

It consists of Ordinary, Honorary, and Ex-officio Fellows.

Ordinary Fellows are elected on a Certificate of Recommendation signed by three Fellows, stating the names, residence, description, &c., of the Candidate, of whom one of the proposers must have personal knowledge. The Certificate is read at a Monthly Meeting, and the Candidate balloted for at the succeeding Meeting.

The Annual Subscription is 2*l.* 2*s.*, payable in advance on election, and subsequently on 1st January annually, with an Entrance Fee of 2*l.* 2*s.* Future payments of the former may be compounded for at any time for 31*l.* 10*s.* Fellows elected at a meeting subsequent to that in February are only called upon for a proportionate part of the first year's subscription, and Fellows absent from the United Kingdom for a year, or permanently residing abroad, are exempt from one-half the subscription during absence.

Honorary Fellows (limited to 50), consisting of persons eminent in Microscopical or Biological Science, are elected on the recommendation of three Fellows and the approval of the Council.

Ex-officio Fellows (limited to 100) consist of the Presidents for the time being of such Societies at home and abroad as the Council may recommend and a Monthly Meeting approve. They are entitled to receive the Society's Publications, and to exercise all other privileges of Fellows, except voting, but are not required to pay any Entrance Fee or Annual Subscription.

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

The Meetings are held on the second Wednesday in each month, from October to June, in the Society's Library at King's College, Strand, W.C. (commencing at 8 P.M.). Visitors are admitted by the introduction of Fellows.

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

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

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows on Mondays, Tuesdays, Thursdays, and Fridays, from 11 A.M. to 4 P.M., and on Wednesdays from 7 to 10 P.M. It is closed during August.

Forms of proposal for Fellowship, and any further information, may be obtained by application to the Secretaries, or Assistant-Secretary, at the Library of the Society, King's College, Strand, W.C.