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.

Ser. II.—VOL. II. PART 1.

PUBLISHED FOR THE SOCIETY BY

WILLIAMS & NORGATE,

LONDON AND EDINBURGH.

1882.

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 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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CONTENTS.

TRANSACTIONS OF THE SOCIETY—

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.

B.—INVERTEBRATA.

---

* The titles of the papers and notes printed in the 'Transactions' and 'Proceedings' are also included here to make the classification complete.

Mollusca.

Molluscoida.

Arthropoda.

α. Insecta.

β. Myriapoda.

γ. Arachnida.

δ. Crustacea.

Vermes.

Echinodermata.

Cœlenterata.

Porifera.

Protozoa.

BOTANY.

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

B.—Cryptogamia.

Cryptogamia Vascularia.

Muscineæ.

Lichenes.

Algæ.

MICROSCOPY.*

a. Instruments, Accessories, &c.

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* Papers and notes abstracted in the Bibliography are also included here.

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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OF TH

ROYAL MICROSCOP[illegible]L SOCIETY.

Ser. 2.—Vol. I[illegible]. Part 1.

(FEBRUARY, 1882.)

CONTENTS.

SUMMARY OF CURRENT RESEAR[CHE]S, &c.—*continued.*

BOTANY.

Summary of Current Researches, &c.—*continued.*

Royal Microscopical Society.

MEETINGS FOR 1882,

At 8 p.m.

1882.	Wednesday,	January	11
	„	February	8
		(*Annual Meeting for Election of Officers and Council.*)	
	„	March	8
	„	April	12
	„	May	10
	„	June	14
	„	October	11
	„	November	8
	„	December	13

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.

NOMINATIONS FOR THE COUNCIL.

8th FEBRUARY, 1882.

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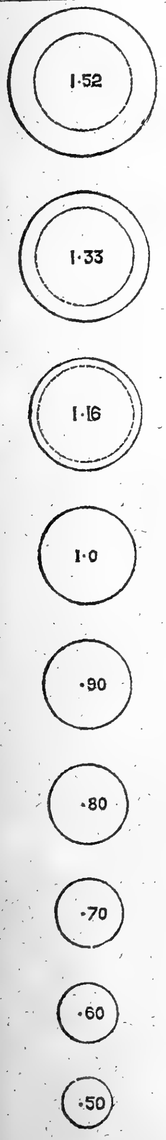
* Have not held during the preceding year the office for which they are nominated.

I. Numerical Aperture Table.

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

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



Diameters of the Back Lenses of various Dry and Immersion Objectives of the same Power ($\frac{1}{8}$ 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. ($\frac{1}{a}$)
		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

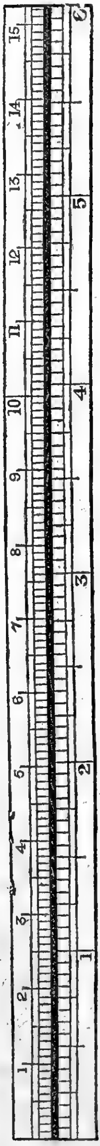
Example.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil). Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal.

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.)	

μ	ins.
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		5·831006
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
	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.

	(Mean values.)
Diamond	2·44 to 2·755
Phosphorus	2·224
Bisulphide of carbon	1·678
Flint glass	1·576 to 1·642
Crown glass	1·531 to 1·563
Rock salt	1·545
Canada balsam	1·540
Linseed oil (sp. gr. ·932)	1·482
Oil of turpentine (sp. gr. ·885)	1·478
Alcohol	1·372
Sea water	1·343
Pure water	1·336
Air (at 0° C. 760 *mm.*)	1·000294

(2.) Dispersive Powers.

Diamond	·038
Phosphorus	·128
Bisulphide of carbon	
Flint glass	·048 to ·052
Crown glass	·033
Rock salt	·053
Canada balsam	·045
Linseed oil (sp. gr. ·932)	
Oil of turpentine (sp. gr. ·885)	·042
Alcohol	·029
Sea water	
Pure water	·035
Air	·1865

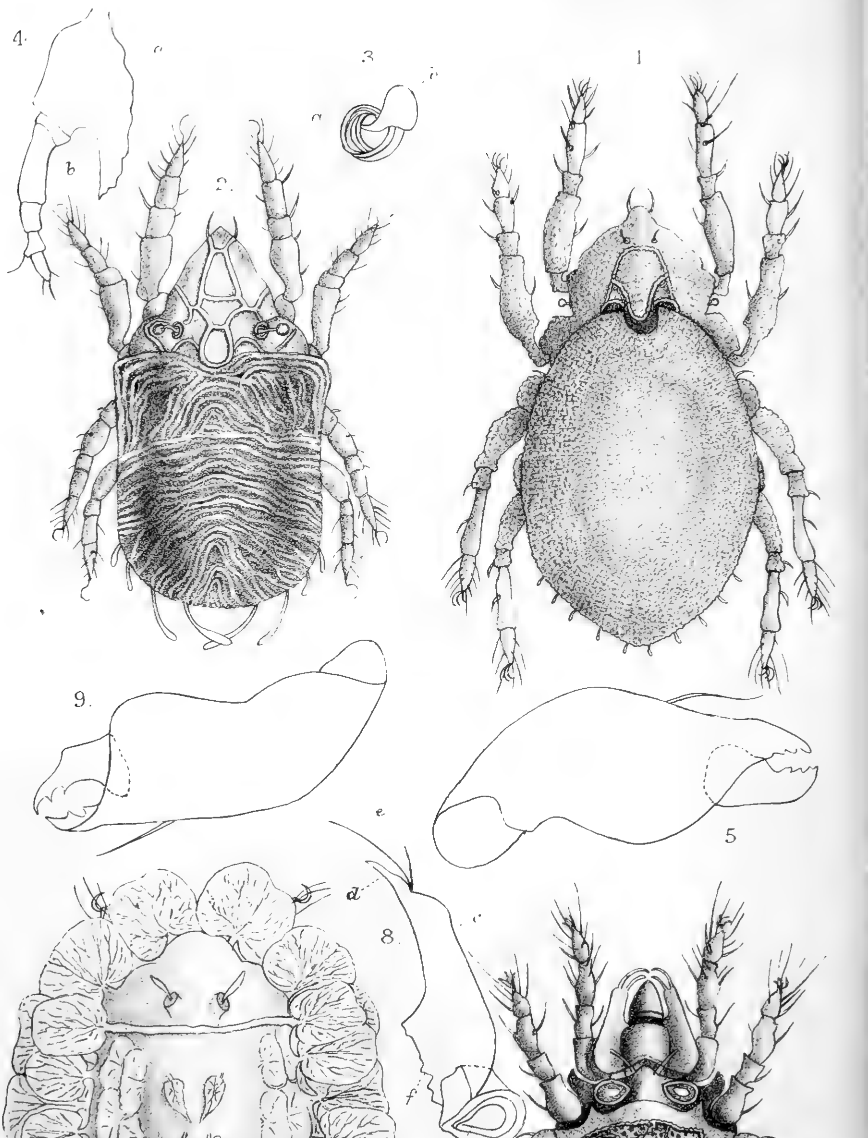
(3.) Polarizing Angles.

Diamond	67° 43′ to 70° 3′
Phosphorus	65° 47′
Bisulphide of carbon	59° 12′
Flint glass	57° 36′ to 58° 39′
Crown glass	56° 51′ to 57° 23′
Rock salt	57° 5′
Canada balsam	57° 1′
Linseed oil (sp. gr. ·932)	55° 59′
Oil of turpentine (sp. gr. ·886)	55° 55′
Alcohol	53° 55′
Sea water	53° 20′
Pure water	53° 11′
Air	45° 0′

V. Table of Magnifying Powers.

OBJECTIVES. Focal Length.	OBJECTIVES. 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.	1⅓ in.	1 in.	⅘ in.	⅔ in.	½ in.	4/10 in.	⅓ in.	¼ in.
		Magnifying Power.								
		5	7½	10	12½	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	2½	12½	18¾	25	31¼	37½	50	62½	75	100
3	3⅓	16⅔	25	33⅓	41⅔	50	66⅔	83⅓	100	133⅓
2	5	25	37½	50	62½	75	100	125	150	200
1½	6⅔	33⅓	50	66⅔	83⅓	100	133⅓	166⅔	200	266⅔
1	10	50	75	100	125	150	200	250	300	400
8/10	12½	62½	93¾	125	156¼	187½	250	312½	375	500
¾	13⅓	66⅔	100	133⅓	166⅔	200	266⅔	333⅓	400	533⅓
⅔	15	75	112½	150	187½	225	300	375	450	600
½	20	100	150	200	250	300	400	500	600	800
4/10	25	125	187½	250	312½	375	500	625	750	1000
⅓	30	150	225	300	375	450	600	750	900	1200
3/10	33⅓	166⅔	250	333⅓	416⅔	500	666⅔	833⅓	1000	1333⅓
¼	40	200	300	400	500	600	800	1000	1200	1600
⅕	50	250	375	500	625	750	1000	1250	1500	2000
⅙	60	300	450	600	750	900	1200	1500	1800	2400
1/7	70	350	525	700	875	1050	1400	1750	2100	2800
⅛	80	400	600	800	1000	1200	1600	2000	2400	3200
1/9	90	450	675	900	1125	1350	1800	2250	2700	3600
1/10	100	500	750	1000	1250	1500	2000	2500	3000	4000
1/11	110	550	825	1100	1375	1650	2200	2750	3300	4400
1/12	120	600	900	1200	1500	1800	2400	3000	3600	4800
1/13	130	650	975	1300	1625	1950	2600	3250	3900	5200
1/14	140	700	1050	1400	1750	2100	2800	3500	4200	5600
1/15	150	750	1125	1500	1875	2250	3000	3750	4500	6000
1/16	160	800	1200	1600	2000	2400	3200	4000	4800	6400
1/17	170	850	1275	1700	2125	2550	3400	4250	5100	6800
1/18	180	900	1350	1800	2250	2700	3600	4500	5400	7200
1/19	190	950	1425	1900	2375	2850	3800	4750	5700	7600
1/20	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
1/25	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
1/30	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
1/40	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
1/50	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
1/60	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
1/80	800	4000	6000	8000	10000	12000	16000	20000	24000	32000

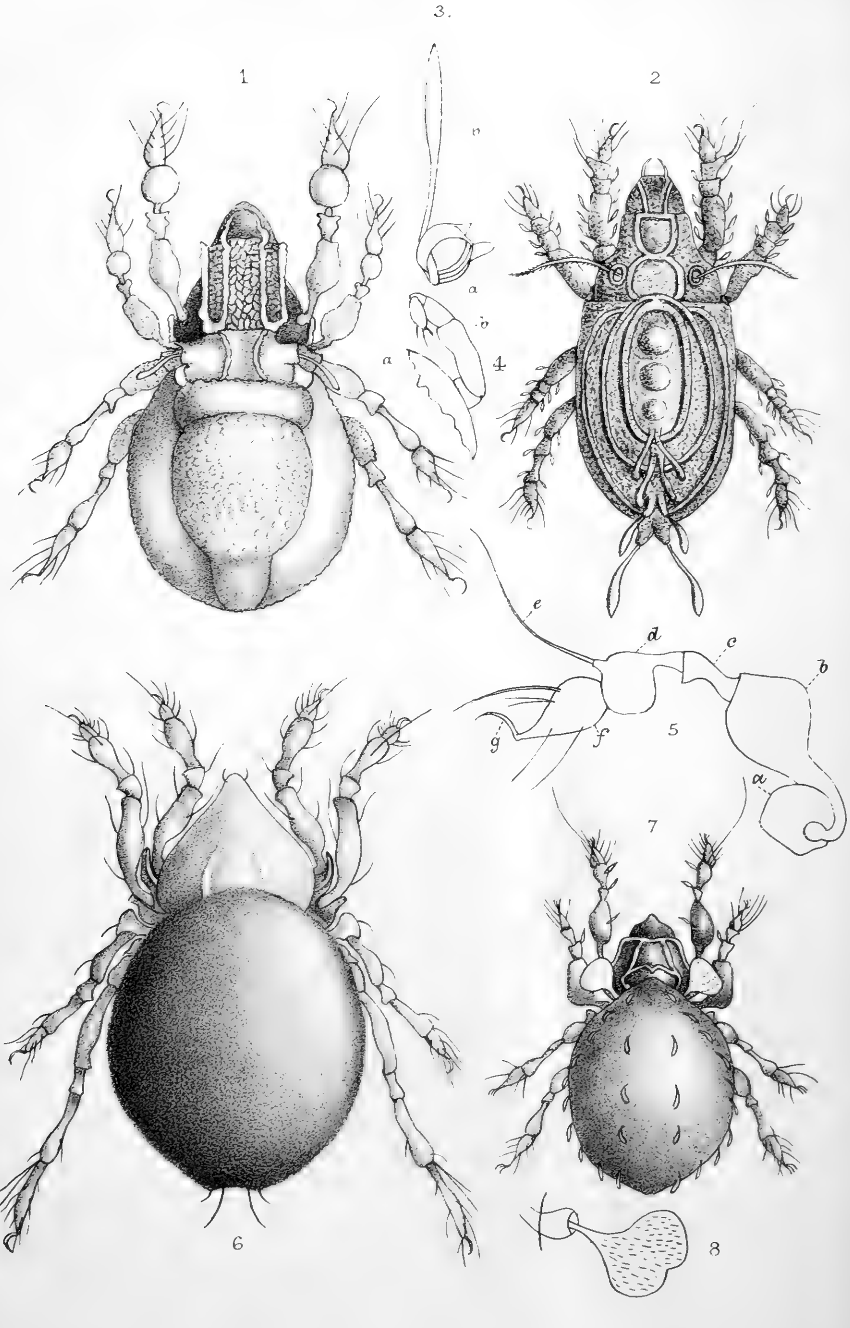
* Powell and Lealand's No. 2 = 7·4, and Beck's No. 2 and Ross's B = 8 magnifying power, or respectively 1/75 less and 1/15 more than the figures given in this column.



A. D. Michael ad nat. del.

West Newman & C° lith.

Scutovertex maculatus 1 – 5.
Cepheus ocellatus 6 – 9.



A.D. Michael ad nat del

West, Newman & Co lith

Damæus monilipes 1–5.
Notaspis lacustris 6.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY 1882.

TRANSACTIONS OF THE SOCIETY.

I.—*Further Notes on British Oribatidæ.*

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

(*Read* 14*th December*, 1881.)

Plates I. and II.

Since my last communication to this Society, I have continued my observations upon the life-histories, and general habits of the native species of *Oribatidæ*, and also my collection of these minute

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EXPLANATION OF PLATES I. and II.

Plate I.

Fig. 1.—*Scutovertex maculatus*, adult. × 160.
" 2.—The same, nymph.
" 3.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 370.
" 4.—The same, adult; *a*, portion of maxillary lip; *b*, palpus. × 370.
" 5.—The same, adult; mandible. × 370.
" 6.—*Cepheus ocellatus*, adult. × 80.
" 7.—The same, nymph, nearly full grown; showing larval and two nymphal cast notogastral skins, the bordering scales of the existing skin not having yet passed far beyond those of the former skin.
" 8.—The same, adult; *a*, stigma; *b*, stigmatic organ; *c*, wing of the tectum; *d*, terminal spine of same; *e*, hair set in at commencement of spine; *f*, portion of the tectum. × 170.
" 9.—The same, adult; the mandible. × 370 (reversed).

Plate II.

Fig. 1.—*Damæus monilipes*, adult. × 160.
" 2.—The same, nymph, full grown; showing the larval and two nymphal cast notogastral skins.
" 3.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 350.
" 4.—The same, adult; *a*, portion of maxillary lip; *b*, palpus with 5th joint reflexed. × 450.
" 5.—The same, adult, 1st leg; *a*, coxa; *b*, trochanter (so called); *c*, femur (so called); *d*, enlarged tibia; *e*, tactile hair on same; *f*, tarsus; *g*, monodactyle claw.
" 6.—*Notaspis lacustris*, adult. × 105.
" 7.—*Notaspis licnophorus*, adult. × 180.
" 8.—The same, adult; *a*, stigma; *b*, stigmatic organ. × 570.

creatures, with a view to making our fauna more generally known. It is the experience of every one entering upon an almost untrodden path in natural history, or indeed in any other science, that at first new species and new facts accumulate rapidly and easily, while, after a time, novelties, whether of observation or of species, are more difficult to find and more laborious to follow out. I am not an exception to this rule, and naturally I cannot record the number of additions which I was able to make in my former papers. My searches have, however, been rewarded by finding species which I believe to be not only new to Britain, but entirely unrecorded anywhere, and which are far too numerous to be figured in the necessarily and properly limited number of plates which the kindness of this Society can place at my disposal. I do not think that written descriptions of creatures of this nature are of much real service without drawings, as, after all, words are but a vague way of identifying form upon which so much depends. I also think that drawings, to be of use to other naturalists, must be upon a sufficient scale to show detail, particularly with such organisms as the *Oribatidæ*, where specific distinctions depend greatly upon the formation of the essential parts of the cephalothorax, which in itself is frequently very small in proportion to the abdominal region. I have therefore thought it best, in this paper, to describe and figure a few of the more interesting unrecorded species with, I hope, some degree of exactitude, rather than to figure a larger number upon a scale which might possibly not be sufficient for identification hereafter.

Before proceeding to notice the unrecorded species, I will deal with such further observations as I can place before you relative to the habits, &c., of this family of *Acarina*.

Deposition or Protection of the Ova.

It will be found, by those who read works referring to this subject, that a great number of naturalists broadly state that the *Oribatidæ* are viviparous. I am not quite sure where the idea originated; some suppose that Claparède is responsible for it, but I fail to find anything in the writings of that excellent observer which in any way justifies the accusation. His only work treating of any of the *Oribatidæ*, as far as I am aware, is his chapter on the development of *Hoplophora contractilis* (as he calls it), in his 'Studien an Acariden,' and in this he expressly says that the idea is erroneous. It is not of much importance where the suggestion came from, but it is more worthy of remark that it has found its way into the works of some of the ablest and most accurate writers, who of course did not take it, or profess to take it, from their own observations, but simply on the authority of others; thus, for instance, Huxley,* talking of the Acarina, says: "Most are oviparous, but the *Oribatidæ* are viviparous." This statement, in spite of the high authority for it, is certainly an error, although there may be a few exceptional instances of it, as will be seen later on in this paper, but those instances are, as far as I am aware, recorded here for the first time. The impression which has got abroad among naturalists, and held its ground so tenaciously, is, perhaps, the more curious, because Nicolet, the principal author who has written upon the *Oribatidæ*, says that the egg is deposited, and that the larva emerges very shortly afterwards, and this dictum of the French acarologist, in my opinion, correctly states what really occurs in a great many, and probably in the large majority of instances.

The result of my own observations has been to convince me that the matter is not quite so simple as naturalists have supposed, and that it is not possible to lay down one general rule which will be correct in all cases; indeed, this remark is applicable to most questions connected with *Acarina*. I have usually found that if I have attempted to generalize from a few known instances the rule which I thought I had found has broken down, and I have also found that a great number of the general laws enunciated by other observers fail to stand the test of a wider experience.

It seems to me that there are at least three if not four modes by which the eggs are brought to maturity, and the larvæ hatched, in different species, or under different circumstances.

The first method is that so well known in insects, that the egg is deposited in a fertilized but only slightly developed state. The long ovipositor, or extensile oviduct, of the female Acarid is used for this purpose, and the egg is placed in crevices of the wood, moss, or fungus, upon which the larva will feed; the egg adheres, either by a certain viscid quality in its exterior envelope, or more often is attached by a few threads of silk-like substance. Segmentation may have gone on in the egg to some extent before deposition, but very little progress has been made towards the differentiation of any individual parts of the future larva. A very considerable time often elapses between the deposition of the egg and the hatching of the larva in this mode, and I think that the creature probably often passes the winter in the egg state, and is only hatched on the approach of spring. I have frequently had the eggs myself for a long time before hatching in various species, as, for instance, *Damæus geniculatus*, *D. clavipes*, *Nothrus theleproctus*, &c.

The second mode is that which Nicolet apparently considered to be universal, and which I myself believe to be the most frequent, particularly in full summer. This is, that the development of the

* 'A Manual of the Anatomy of Invertebrated Animals.' London, 1877, p. 383.

egg is almost completed within the body of the living mother, and that the egg is extruded, certainly as an egg, as in the first method, but with the larva so fully developed that it escapes from the ovum very shortly after deposition.

I have a strong suspicion that a third mode, only to be found in exceptional instances, is that which Huxley states to be characteristic of the family, viz. that the female is viviparous or ovo-viviparous. This, if it occur at all, is probably not the case at all seasons of the year, even in the species where it may take place during the period of most rapid reproduction. I have not any proof or certainty that this mode ever exists, for I have not ever witnessed the birth of a living larva, unenveloped in any egg-shell, from any of the *Oribatidæ*, but I have dissected out of the body of a female, either living, or killed immediately before, a larva, which, although not sufficiently strong or active to run, has been fully developed, and able to kick its legs and move its trophi in a very vigorous manner, and exhibit other signs of life. In addition to this, I have several times found larvæ in a cell where I had kept a pair of adults, and which I had carefully examined for ova a short time before without detecting any. I do not place much reliance upon this last reason, as the ova are sometimes extremely difficult to find in consequence of their smallness, their want of colour, and the places in which they are laid; but, as far as it goes, it is in favour of the occasional viviparous theory.

In the above-named three methods only one, or at the utmost two eggs are matured at one time; the reason for this is evident enough, as the egg is so large as to appear disproportionate to the size of the body, and many could not be ripe at once consistently with the life of the Acarid.

I believe that the fourth method has not hitherto been recorded by any observer, and it appears to me interesting. I have noticed it chiefly in the case of *Oribata globula*, but it probably exists in other species. It is as follows: The female, instead of maturing only one or two eggs at the same time, matures a much larger number, often a dozen or more, so that the abdomen appears to be entirely filled with them; these eggs are not laid, neither do they hatch within the body of the living mother, but the mother dies with the abdomen distended by fully formed eggs, in which the larvæ have not been developed. The whole contents of the abdomen except the eggs seem to dry up and disappear, leaving the chitinous shell of the parent as a protection to the ova. This condition of matters often lasts for a considerable time, indeed I believe that *Oribata globula* often, or usually, passes the winter in this state. When the larvæ are at length hatched, they escape by the opening of the camerostomum, the labium having probably dropped off, or by the genital or anal opening, the folding doors which close these respective apertures having also dropped off. Sometimes the apertures are so small, or the larvæ so large, that they cannot easily escape by the apertures, and I have more than once had to assist those I had bred in confinement by breaking away the shell.

Dr. G. Haller, of Bern,* lately recorded the finding of numerous dried exo-skeletons of *Hoplophora* in winter among the fallen leaves, each shell having a large single mature egg in it. Haller concludes that the female *Hoplophora*, when about to deposit an egg, seeks for the exo-skeleton of some deceased member of its own species, and uses it as a shelter for the egg. It is of course quite possible that this may be so—I cannot deny it—but, as Haller does not appear to have seen the egg laid, and he was hardly likely to have done so, as the *Oribatidæ* object to light, I cannot help thinking that this is probably another instance of the fourth method above described, with the distinction that here only one egg is matured at once. If it be not so, it is odd that the *Hoplophora* should always choose the exo-skeleton of a *Hoplophora* instead of distributing its favours more generally amongst other genera.

Deutovum Stage.

Another observation which I have to record, is relative to the development of the egg after extrusion. The eggs of some *Oribatidæ* are of a rather leathery consistency, those of other species are provided with a hard chitinous shell, which is brittle and non-elastic. Claparède, in his 'Studien an Acariden,' records the occurrence, in the ova of *Atax bonzii*, of what he calls a deutovum stage; Megnin has observed a similar thing in the case of *Trombidium fuliginosum*, and I myself noticed it in the ova of other *Trombidiidæ*, but I am not aware of any one having observed it amongst the *Oribatidæ*. I have now to record that it decidedly is equally a portion of the life-history of some, but not of all, members of this family. The deutovum stage is as follows: When the exterior shell of the egg is hard and non-extensile, the gradual increase of volume in the egg-contents produces so much pressure from within upon the shell that the latter splits sharply all round its periphery, dividing it into two somewhat boat-shaped halves; the inner membrane which lines the shell has in the meantime increased in strength, and has become the true envelope. The space between the two broken halves of the exterior shell is at first a mere line, but, as the contents increase, this line widens, and the halves of the old shell get pushed further and further apart, showing a broad white space (the inner membrane)

* "Miscellanea acarinologica," MT. d. Schweiz. entom. Gesellschaft, 1879, No. 4, p. 502.

between them. It is along this line that the rupture takes place when the larva escapes, as recorded in my first paper on the *Oribatidæ* in this Journal.*

Wood-boring Species.

Claparède, in his 'Studien an Acariden,' records the result of his excellent observations on *Hoplophora* in its immature stages, his discovery that the larvæ and nymphs were wood-boring creatures, and he expresses his astonishment at finding that the nymphs and larvæ were soft white creatures, when the adults are so hard and dark; he calls it passing through an Acarus stage. I find that *Hoplophora* is not by any means an exceptional instance in either of these particulars. The nymphs of *Hermannia arrecta*, *Tegeocranus elongatus*, *Cepheus vulgaris*, and some others, live in dead wood, which they perforate with long burrows in all directions, until the wood is often thoroughly riddled by them, only the thinnest partition being left between the burrows. The larva or nymph, as the case may be, is usually found at the end of the burrow furthest from the mouth, being in fact the last place which it has worked to; the burrow behind it is usually filled with excremental matters and wood-dust. The nymph of *Tegeocranus coriaceus* burrows into the more solid fungi in exactly the same manner, and there are doubtless other boring species which I have not yet traced. It is rather interesting to observe that, in all of these instances, the larvæ, or nymphs, are soft, white creatures, entirely without the defensive armour or other protection possessed by members of the family which are more exposed to danger than these sub-cortical species.

Ecdyses of Leiosoma palmicinctum.

Those who have seen the beautiful nymph of *Leiosoma palmicinctum*, which is figured in a former paper of mine in this Journal,† will not readily forget it. I was curious to see how the very large Japanese-fan-shaped, membraneous hairs, which form a broad border round the abdomen of the nymph of this species, were disposed of during the formation or ecdysis. I had naturally imagined that they would be folded up, either by closing the nervures together like a fan, or else transversely like the wings, &c., of insects. The extremely simple and pretty method by which nature effects the packing did not strike me. The elegant membraneous hairs grow on the edge of the body, and are formed fully expanded; instead of being doubled up, their peduncles are simply turned down a little, so that the palmate hairs lie flat against the ventral surface of the Acarid, and are thus protected from injury;

* Vol. II. (1879) p. 225. † Vol. III. (1880) Pl. III.

the two pairs of immensely long setiform hairs, which spring from the edge of the abdomen, are also bent down upon the ventral surface, instead of being folded, and there form a diagonal cross. The whole arrangement may be most distinctly seen through the existing skin, pending one of what, for want of a better name, I call the inter-nymphal ecdysis, i. e. a change of skin which does not take place upon any transformation, but simply upon the nymph growing larger. I have luckily succeeded in mounting a specimen in this condition which shows the whole arrangement admirably. I have not figured it from want of space.

New Species.

Among the unrecorded species described and figured below are one or two which may be worthy of some remark, although I have not any very striking novelty to record this time.

In my paper published in the third volume of this Journal, page 186, at the end of the description of the nymph of *Leiosoma palmicinctum*, I stated that I had brought home what I had supposed to be several very young specimens of that nymph found upon the golden lichens growing upon the rocks of the Land's End, but that, when examined with a higher power, they turned out to be a different species, the shape being slightly longer, and the nervures of the palmate hairs irregularly furcate instead of reticulated. I also stated that they had not attained the adult condition, and that I doubted their surviving the winter; that doubt became considerably stronger as the winter advanced, for my captives became to all appearance dead, and I feared that the only thing to be done with them was to mount them as specimens. I was still unwilling to abandon a hope, however remote, of tracing the species, and my patience was in this case rewarded, for, as the spring advanced, the apparently dead nymphs began to move about very slowly, and finally underwent their last transformation, and there emerged an adult, which was new to me, and I believe unrecorded, and which was moreover quite distinct from anything I had seen, and was a handsome species. The interesting part was, however, that, although the two nymphs resembled each other so closely that it required a careful examination with a moderately high power to find out the difference, and although they were utterly different from all other known nymphs, and notwithstanding that they came from the same place and both fed upon lichen, yet the imagos were quite dissimilar, and not in any way to be included even in the same genus. *Palmicinctum* is a *Leiosoma*, and the present species, although it does not fit very well into either of Nicolet's genera, yet is certainly a *Cepheus*, unless a new genus were made for it, which does not seem to me to be desirable. I have called it *ocellatus* from the curious effect, like two great eyes, produced by the globular stigmatic organs (or protecting hairs as Nicolet calls them) being sunk exactly in the mouths of the stigmata. This is the only instance of such an arrangement which I am aware of in the *Oribatidæ.*

Another somewhat singular creature is the very minute being which I propose to call *Notaspis licnophorus:* here again the peculiarity is in the stigmatic organs, which are flattened, and so large as to appear quite disproportioned to the Acarid. When I have had this tiny creature alive on the stage of the Microscope for the purpose of observing or drawing it, I have seen the stigmatic organs blown about by the wind.

A third very curious new species is the one I propose to call *Damæus monilipes:* the remarkable part of this creature is the form of the legs, particularly the first pair, where the tibia is a globular mass which appears altogether too large for the Arachnid, and gives it the effect of carrying a mace on each side.

A fourth curious species I propose to call *Notaspis lacustris:* the peculiarity is its being strictly aquatic, and being often found covered with diatoms.

In conclusion I may briefly allude to certain slides which have been in circulation of late as being mounts of an *Acarus* supposed to feed upon the *Phylloxera;* those that I have seen have been a collection of various *Acarina,* of different families—in fact anything and everthing found upon a vine; amongst them were more than one of the *Oribatidæ.* I think that such information should be received with extreme caution, as I am not aware of any well-authenticated instance of any species, which really belongs to this family, being habitually predatory.

Descriptions of Species.

CEPHEUS OCELLATUS *n. sp.* Pl. I. Figs. 6–9.

Average length about ·6 mm.
" breadth " ·32 mm.
" length of legs 1st, 2nd, and 3rd pairs about ·24 mm.
" " " 4th pair about ·32 mm.

This species does not fit very happily into any of Nicolet's genera, but I do not think it is desirable, at present, to create a new genus for it. The only one of the existing genera in which it can be included is *Cepheus,* and in that genus I accordingly place it provisionally.

It is a somewhat singular, and very well marked species. The *colour* is very dark brown, often almost black, and the texture is dull, without the slightest gloss.

The cephalothorax is rather more than a third of the total length, broad, and flat. The rostrum blunt, the tectum large and well marked, its wings (or lamellæ) very large, nearly on edge, and projecting far beyond the anterior edge of the horizontal surface of the tectum; at their anterior termination these lamellæ are truncated and slightly rounded, from the lower angle of the truncated edge springs a stout spine, which curves forward and downward, and almost touches the tip of the rostrum. A little above this spine, on the same truncated edge, is a much thinner but rather longer spine, or hair, almost parallel to the thicker one. Each lamella increases in width as it nears the abdomen, and terminates suddenly, with a rounded shoulder, just in front of the stigma. The stigmata are placed at the junction of the cephalothorax and abdomen, they are very large and open: the opening faces straight upward. The stigmatic organs (or hairs) are globular, and are sunk in the mouth of the stigmata, which gives each stigma the appearance of being an enormous eye—it is from this effect that I have named the species. This peculiarity alone would be sufficient to distinguish the present species at a glance from every other which I am acquainted with. The interstigmatic hairs are short spines just inside the stigmata. The palpi are subcylindrical, with the first joint much the longest, the third and fourth very short, the fifth conical and densely haired, labium longer than broad, mandibles very small.

The *legs* are stout, all joints except the tarsi very rough and irregular in outline, the second joints much the thickest, the tarsi short and stout. The first two pairs reach considerably beyond the rostrum, the fourth pair only slightly beyond the posterior margin. The tarsi are clothed with numerous very thick hairs, the other joints have very few hairs on them.

The abdomen is oval, truncated anteriorly, with the antero-lateral angle produced so as to form short points projecting forward and almost touching the stigmata. There is a broad flattened margin, somewhat raised towards the edge, all round the abdomen, except where it joins the cephalothorax; this band bears a row of blunt spines, not quite regularly arranged; inside the band the notogaster is arched, but not very strongly; it is divided by ridges into irregular strips or bands, of which one or two run nearly parallel to the anterior margin and the rest run more or less longitudinally. There are usually about ten bands in the width; each band contains two rows of round pits, the position of the pits being alternate, i. e. the pits in one row come between, and not opposite to, the pits in the adjoining row. The anal plates are very large, and the genital plates are close to them; both sets are sub-oblong in form.

The Nymph.

This is so similar to the nymph of *Leiosoma palmicinctum* * that I think it will be convenient to point out the differences rather than to describe the whole creature again. The present species is a rather longer and narrower elliptical form than *palmicinctum.* The beautiful expanded membraneous hairs, each shaped like a Japanese fan, which form a broad border all round the creature in both species, are similarly arranged along the lateral and posterior margins of the abdomen in both species, but in *palmicinctum* they also run round the anterior margin, entirely covering up the cephalothorax. In the present species they are absent from the anterior margin of the abdomen, but they complete the elliptical border of hairs by running round the margin of the cephalothorax itself, and a similar hair on each leg of the first pair completes the border below the rostrum. This hair is absent in the nymph of *palmicinctum,* but is present in the larva of that species. The result of this arrangement is that the cast notogastral skins borne on the back of the nymph have not any expanded hairs along their anterior margins, *palmicinctum* has. There are three pairs of similar hairs, but longer and more pointed in form, down the centre of the notogaster, being in fact upon the notogastral portion of the cast larval skin. Another very leading distinction between the two species is that in *palmicinctum* the nervures of the expanded membraneous hairs are reticulated, whereas in *ocellatus* they are irregularly branched.

The stigmata and stigmatic hairs (or organs), which are hidden in *palmicinctum,* are present and conspicuous in *ocellatus;* the organs are somewhat lancet-shaped. Another great difference is the entire absence in the present nymph of the four immensely long hairs which project round *palmicinctum.*

In other respects than those above named the same description would serve for both species, although the adults are so different.

I have only found the species upon the yellow lichens which clothe the granite rocks of the Land's End, Cornwall; it is not common even there.

NOTASPIS LICNOPHORUS,† *n. sp.* Pl. II. Figs. 7, 8.

Average length about ·19 mm.
„ breadth „ ·11 „
„ length of legs, 1st and 4th pairs, about ·1 mm.
„ „ 2nd „ 3rd „ „ ·08 „

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* Described in this Journal, iii. (1880), p. 184.
† Λικνον, a fan; φερω, I bear.

This extremely minute species is principally distinguished by the disproportionately large size and unusual shape of the stigmatic organs, from which I have named it.

The *colour* is light yellow-brown, and the whole dorsal surface is highly polished.

The *cephalothorax* is considerably narrower than the greatest width of the abdomen, but at the actual point of juncture the cephalothorax is slightly the wider, and is partially hidden by the advancing anterior point of the latter. There is a small central point to the rostrum, which then has a very obtuse angle, and, after attaining nearly its full width, becomes more parallel-sided. The cephalothorax widens suddenly at the anterior edge of the tectum, which projects beyond the lateral margin of the rostrum. The central portion, or tectum proper, although attached to the cephalothorax by its whole surface, has the position of the lamellæ marked by two strong ridges joined by a transverse ridge anteriorly, and also joined posteriorly, not far from the abdomen, by another ridge, not straight, but forming three angles, the central pointing backward, and the two lateral ones pointing forward; after these join the ridges which represent the lamellæ, the two united ridges turn sharply inward to escape, and border, the inside of the stigmatic elevation. *The stigmatic organs are of moderate length, very broad, and flattened out, and resemble the Japanese or Indian fans,* only that the distal margin is slightly undulated; these organs are marked with lines of elevated dots, and from their large surface they are blown about a little by the wind.

The legs are of moderate length, the second joints very thin at their insertion, but suddenly, and much enlarged, narrowing again somewhat at the distal end; the third joints very small and fine; the tibiæ wineglass-shaped, much enlarged at the distal margin; the tarsi short and stout, *the triple claws very heterodactyle.* This latter point, according to Nicolet's definition, would prevent the creature being included in the genus *Notaspis.* The tibiæ of the first pair of legs have the tactile hair long, the tarsi have numerous fine hairs, and there are one or two short spatulate hairs on each of the other joints of each leg.

The *abdomen* is elliptical, pointed anteriorly and posteriorly, the anterior point being the sharpest. There is a close row of short, curved spatulate hairs round the margin, and two longitudinal rows of about three similar hairs near the centre of the notogaster.

I have found the creature in decayed wood at Tamworth, in Warwickshire, and at Epping Forest; it is not common. I believe it to be unrecorded.

Nymph.

The nymph of this species so closely resembles the perfect form that I do not think any one would mistake it. I therefore have not figured it, and only give here the differences from the perfect form (beyond the ordinary one of being monodactyle instead of tridactyle).

The *colour* of the nymph is pure milky white, without a speck of darker marking about it.

The general thickness of the legs is greater in the nymph, and the shapes of the respective joints are not so varied.

The markings figured upon the cephalothorax of the adult are not found on the nymph.

The hairs bordering the abdomen are rather smaller in the nymph than in the adult.

The skin is covered with slight wrinkles or vermiform markings instead of being polished.

NOTASPIS LACUSTRIS, *n. sp.* Pl. II. Fig. 6.

Average length about ·5 mm.
„ breadth „ ·33 „
„ length of legs, 1st pair, about ·26 mm.
„ „ 4th „ „ ·40 „

I have ventured to include this species in the genus *Notaspis*, although this is a monodactyle species, and Nicolet defines the genus as tridactyle; but I have come to the conclusion that, although it was perfectly natural for Nicolet, working from the species he was acquainted with, to take the number of claws as distinctive of genus, yet there are some genera in which this cannot be supported as a good characteristic.

This species is strictly aquatic, but is not a swimming creature; indeed, none of the *Oribatidæ* are. It crawls about the subaqueous plants, and is confined to fresh water. It is often found covered with diatomaceæ, which adhere to it sufficiently tightly to be preserved upon it.

The *colour* is dull reddish-brown; the texture is smooth but not polished.

The *cephalothorax* is less than half the length of the abdomen, and forms a broad, short cone, with a slightly rounded apex; it is considerably rounded at the posterior angles. The base is almost as wide as the anterior margin of the abdomen. There are not any markings on the dorsal surface, except two short ridges, which are doubtless the homologues of the wings of a tectum, but otherwise that part is absent. The stigmatic organs are not visible, and there are not any interstigmatic hairs; the rostral hairs are short and curved.

The *legs* of the first two pairs are set in deep clefts of the projecting lateral portions of the sternum; they have a tendency to set outward. The second and fourth are the principal joints, the tarsi being short and thick. Each tibia bears a long tactile hair; the tarsi have numerous fine hairs, and the other joints, except the coxæ, mostly have a few longish, fine hairs, chiefly arranged in whorls.

The abdomen is a short ellipse, not far from a circle, and is very slightly truncated posteriorly. This truncated portion bears two pairs of short, fine hairs, the inner pair being the longest.

I believe I know the nymph of the species, but as I have not actually bred it I refrain from describing it.

The species is common and generally distributed.

SCUTOVERTEX MACULATUS,* *n. sp.* Pl. I. Figs. 1–5.

Average length about ·54 mm.
„ breadth „ ·30 „
„ length of legs, 1st and 4th pairs, about ·33 mm.
„ „ 2nd „ 3rd „ „ ·30 „

The *colour* both of body and legs is dark brown, almost black; the whole dorsal surface is thickly sprinkled with raised dots. These are irregular in shape, and in scattering on the cephalothorax, but on the abdomen, which constitutes by far the larger portion of the creature, they are more even in size and arrangement, being closely packed, and more or less approaching round or subsquare. Towards the lateral and hind margins of the abdomen these dots form lines of dots radiating from the centre of the body, along the front margin they are transverse in arrangement, and in the centre they are irregular, or form labyrinthine lines. These dots projecting make the edge, or any part seen against the light, always appear rough.

The shape of the creature is an elongated ellipse, being nearly twice as long as broad.

The *cephalothorax* is broad and rather large, but is greatly overhung by the anterior margin of the abdomen, which hides a large part of it. The extreme tip of the rostrum is small and rounded, and bears a pair of hairs. From thence the cephalothorax widens suddenly, and becomes much arched, and again widens somewhat suddenly at the insertion of the first pair of legs. There is a tectum very conspicuous, but short and narrow, and without lateral wings, or rather the edges are thickened, slightly raised, and then turned downward, giving an appearance of being attached to the cephalothorax by their whole circumference.

From about the middle of the internal edge of the lateral ridge

* *Maculatus*, spotted.

of the tectum, on each side, another ridge starts and runs backward at an angle, so that the two together form a V-shaped marking, the point of which is rounded, and lies within an indented semicircle in the anterior margin of the abdomen. The elevated markings on the tectum form transverse wavy lines. There is a strong chitinous projection from the side of the cephalothorax between the second and third pairs of legs. The stigmata are near the lateral margin between the first and second pairs of legs. The stigmatic hairs are short, and consist of a small globular head, on a stout filiform peduncle. There are two pairs of short, thick hairs on the dorsal surface of the cephalothorax.

The coxæ of the first two pairs of legs are hidden beneath the body. The trochanters of the same pairs are large and long, but suddenly become small, and turn almost at right angles near their insertion into the coxæ. The coxæ of the third and fourth pairs of legs are rounded and conspicuous. The second and fourth joints are the longest in all the legs, the third joint being the smallest. The first three joints in each leg are covered with irregular raised markings. The tarsi have a few fine hairs round the claws, which are very heterodactyle. There are three short, thick hairs on the fourth joint of each leg of the first two pairs, and a few other similar hairs on the different joints of the legs. All these hairs are very caducous.

The abdomen is elliptical, slightly pointed posteriorly, and slightly truncated anteriorly; it is indented between the insertion of the third pair of legs and the stigma, and the anterior margin is cut out in rather more than a semicircle. This indentation receives the point of the V-shaped ridge on the cephalothorax; and at the side of it the anterior margin of the abdomen is attached to the upper surface of the tectum. There are about ten short, thick hairs round the hind margin of the abdomen, also very caducous.

On the ventral surface the genital plates form almost a square, and are far forward. The anal plates are large, elliptical, and touch the posterior margin.

Nymph.

The *colour* of this curious nymph is dull opaque brown, often with a shade of dark olive green in the brown. It is so broad and flat in general shape as to give the effect of having been flattened out, and it is thickly covered with wrinkles and ridges all over.

The *cephalothorax* is flat, long in proportion to the abdomen, but not in proportion to its breadth, conical, but sharply excavated at the edge, for the insertion of the first pair of legs. The base of the cephalothorax is narrower than the anterior margin of the abdomen, and the second pair of legs are inserted in the angles thus formed. The cephalothorax bears a complicated series of ridges not easy to describe, and which will be best understood by reference to the drawing. I will, however, endeavour to give an idea of their arrangement in words. The median (or axial) portion of the vertex is divided into three spaces bordered by strong raised ridges. The anterior one is trapeze-shaped, with the small end foremost and coming near to the point of the rostrum, but not reaching it. Two short ridges, however, run from the anterior angles of the trapeze, one to each side of the rostrum, very near to the point. The ridge which forms the posterior border of the trapeze forms the anterior border of a hexagon, which has curved sides, convex inwards, the anterior side being the longest, and the two next sides very short. The posterior ridge of the hexagon forms the anterior margin of an oblong or elliptical figure, usually somewhat constricted in the middle. This figure extends back on to the abdomen, so that it is difficult to say where the abdomen commences in the median line. From the central angle on each side of the hexagon a short transverse ridge runs about half-way towards the lateral margin. From its termination a ridge runs forward to the front of the excavation for the first leg, and another, or continuation of the same, runs back to a circular ridge surrounding the stigma, and from the stigma a triangular space bordered by another ridge extends to the lateral margin. The stigmatic organs are short, globular, on a short peduncle, and very white. The interstigmatic hairs are absent or little seen; the rostral hairs are present.

The *legs* are stout and gradually diminished towards the end. The third and fourth joints of the two front pairs each bear a strong serrated spine on the upper side; the other hairs on the legs are short, and the tactile hair is absent.

The abdomen is flat in general effect, but has somewhat raised anterior and lateral edges, and is raised to about the same extent along the median portion, being slightly arched there; between this median portion and the lateral edge is a depressed channel. The whole abdomen is covered with wavy closely-set irregular wrinkles. Three or four of these run along the anterior, and about half-way down the lateral margin; the centre of the space enclosed by these last-named wrinkles is occupied by a set of wrinkles bending strongly forward. Behind them the wrinkles become more transverse, until near the posterior margin, where they again bend strongly forward. The posterior margin is set with eight spatulate hairs, of which the two lateral pairs are very short, the two central pairs much longer and directed inward, the central pair crossing.

I have only found the species on the lichen near the sea-shore, at the Land's End, Cornwall. It has not to my knowledge been recorded before I found it, and it is not common.

DAMÆUS MONILIPES, *n. sp.* Pl. II. Figs. 1–5.

Average length about ·34 mm.
„ breadth „ ·18 „
„ length of legs, 1st pair, about ·17 mm.
„ „ 2nd and 3rd pairs, about ·15 mm.
„ „ 4th pair, about ·19 mm.

This is an extremely minute but rather elaborately formed species. I have included it provisionally in the genus *Damæus*, but that genus will probably require division—perhaps by reviving Koch's genus *Oppia*, and properly defining it, in which case the present might well serve for a type-species. The *colour* is rather light brown, and has a whitish shade over some of the raised parts. It is not very strongly chitinized, and is indeed rather more leathery in texture than most of the family, except the genus *Nothrus*, and, like many other *Oribatidæ* which have this texture, and are thus not as fully protected as harder species, it makes up for the deficiency by covering itself with dirt to such an extent that it is almost impossible to get it clean, its very small size being an additional difficulty. The figure and this description are taken from a carefully cleaned specimen, otherwise many of the details would not be seen. Another source of error, which must be avoided in identifying the species, is that the elevations on the dorsum of the abdomen are apt to lose their form and be very difficult to see shortly after death, particularly if treated with reagents. By care, however, the true form may be preserved.

The division between the cephalothorax and abdomen is very marked. The actual rostrum is short and conical, not a third of the length of the dorsum of the cephalothorax. Behind this the cephalothorax is covered by a tectum or its homologue, but the whole of it is anchylosed to the surface of the cephalothorax, and does not stand free. The lateral edges are straight or slightly concave, but very rough. The anterior edge is rather convex; the wings of the tectum are well marked, and are also anchylosed to the surface of the cephalothorax; they are reflexed, sloping downwards on the side of the cephalothorax. A strong ridge runs along the juncture of each wing with the tectum, and this ridge projects forward beyond the edge of the tectum, forming a strong, rough, curved point, terminated by a hair; indeed, it seems to have taken the place of the projection frequently found at the anterior edge of the wing. The whole tectum is reticulated, but the reticulations are not easily seen on the wings. Behind the juncture of the tectum the cephalothorax rises suddenly, and forms a rough central lump, at the edges of which are the stigmatic tubes projecting to an unusual degree, the stigmata opening at the extreme edge of the body. The stigmatic organs (or hairs) are long, spatulate, rough, and point upward, outward, and backward.

There is a deep depression between the hinder part of the cephalothorax and the abdomen.

The legs are very remarkable, or at least the first pair is. They are by no means so long as is usual in the genus *Damæus*, and the forms of the pieces are singular. The coxæ are not visible from the dorsal aspect, and the expansion of the cephalothorax above mentioned has a deep cleft to admit the upward motion of the thin proximal end of the so-called trochanters of the first pair of legs. This joint is greatly enlarged. The first two pairs of legs have the so-called femurs very short, with a short, thin, proximal, and a much broader, almost square, distal end. The tibiæ of the first pair of legs are the pieces which render the legs exceptional; they are globes which appear disproportionately large, and are borne on extremely short and very thin proximal ends. The tarsi are all pyriform, and thickly clothed with hairs. The enlarged tibia bears a long tactile hair.

The abdomen is elliptical, slightly pointed posteriorly, and strongly truncated in front; its antero-lateral angles are produced into well-marked points, which curve towards the stigmata, so that from the dorsal aspect two open spaces are seen, bounded on the outside by these points, and anteriorly by the coxæ of the third pair of legs. Immediately behind the anterior margin there is a broad, rounded, transverse elevation, not reaching the lateral margin. Behind this is a deep, linear depression, and then the centre of the abdomen, until within a quarter of its length from the hind margin, is occupied by a domed lump, followed by a smaller one, which touches the hind margin. Exterior to these elevations the abdomen is a broad, almost flat, expansion, which seems to form a flat annulus round the central elevation. At the extreme edge of this is a narrow, rough ridge. The annulus curves downward towards the margin, but not very strongly. The whole surface of the abdomen is rough and irregularly sprinkled with raised dots, which are far largest and most conspicuous on the central lump.

The Nymph.

This is also rather a complicated creature, not very easy to describe. The *colour* is light oak-brown, with a tendency to a grey dusty effect over the raised parts of the skin. The texture is a little like fine shagreen, and the general outline is a shield-shaped abdomen surmounted by a bluntly conical cephalothorax.

The *cephalothorax* is rather more than one-third of the whole length; at its base it is nearly as wide as the abdomen. The rostrum is rounded anteriorly, and slightly truncated. A blunt point on each side of the truncation carries the curved rostral hair. The cephalothorax appears arranged in three spaces, which, commencing anteriorly, are, first, the rostrum, which bears two longitudinal ridges commencing close to the above-named points, but sometimes a trifle nearer the lateral margin; the second division extends from the rostrum to the insertion of the first pair of legs, and has a central shield-shaped space on the dorsal surface, enclosed by a raised ridge, against the front of which the ends of the before-named longitudinal ridges abut. A smaller space, narrower in proportion, on the slope of each side, is also enclosed by a ridge. The third portion of the cephalothorax extends to the abdomen, and has a central octagonal space enclosed by a similar ridge, abutting on the shield-shaped ridge anteriorly, and on the abdomen posteriorly. On each side of the octagon is a rounded, somewhat mamillar portion, bearing the stigma, which is dorsal. The stigmatic organs (or hairs) are long, filiform, rough, and sinuous. The interstigmatic hairs are apparently absent.

The *legs* are rather short, of almost even thickness throughout, rough, and with a projecting point on the front tibiæ, which bears a very strong tactile hair. The other joints each have a pair of short, curved, spatulate hairs. The tarsi are short and thick, and clothed with numerous fine hairs.

The *abdomen* carries the cast notogastral skins stretched quite flat on the back, except that the edges of each skin have curled up and form ridges, thus, in the full-grown nymph there are three almost concentric ridges. Within the space enclosed by the inner ridge—i. e. upon the larval skin—are three hemispherical knobs, arranged longitudinally. There are two projecting points at the posterior end of the creature, and of each cast skin, and each point bears a long, spatulate, curved hair.

The creature lives in decayed wood. I first found it in some material brought from Yorkshire by the Rev. H. Tattershall, and I have since found it myself in Hopwas Wood, near Tamworth.

II.—*A New Growing or Circulation Slide.*

By T. Charters White, M.R.C.S., F.R.M.S.

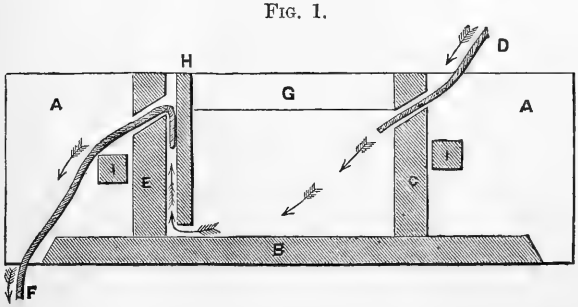
(*Read* 14*th December*, 1881.)

Increasing attention has of late years been devoted to the subject of slides by which the development of microscopical organisms can be observed, but the majority of the forms suggested have been attended by various drawbacks and disadvantages in their design and construction, leading to their disuse. The one here described seems to be as efficient as can be desired; it is, however, merely put forward as a suggestion, and I do not venture to claim for it more than simplicity and efficacy to recommend it to microscopical observers.

It often happens that in examining a gathering from some aquatic source an organism is met with about which the observer would desire to know more, but to transfer it from his slide to one of the growing slides in ordinary use would probably result in its loss or destruction. The slide now described is designed to supersede the use of the glass slip generally used for this examination, so that should such an organism present itself all that is required to maintain a constant current is the insertion of threads of cotton into openings in the sides of the cell. The organism is then duly nourished, and no alteration occurs to interfere with its proper development, which can be readily noted from time to time.

The slide (Fig. 1) consists of the usual glass slip A A (3 in. × 1 in.), having a narrow ledge of glass B (about $\frac{1}{8}$ inch

Fig. 1.



wide, and extending nearly its whole length), cemented to its lower border with marine glue; to this is cemented at right angles a strip of thin covering glass C, about $\frac{1}{4}$ inch wide and about $1\frac{1}{8}$ inch from the end of the slide, having a narrow channel cut through it for the passage of an intake thread D. A similar strip

E, having a like cut through it for the passage of an outlet thread F, is cemented at the same distance from the opposite end of the slide. In this condition the slide being filled with water to the level of G, any current coming in through the intake thread D would pass directly across the top of the water in the cell, and pass out by the outlet thread F, and organisms near the bottom of the cell would not be benefited by a change of water; I therefore cement a very narrow slip H of the same covering glass as before to the inner side of the outlet end of the cell, commencing at the top of the slide, and extending to very nearly the bottom, so as to leave about $\frac{1}{16}$ inch between E and H. If the intake thread is connected with a bottle of water placed above the level of the slide, water entering by the intake thread will pass in a diagonal direction from D to the left and bottom of the cell, where the influence of the suction set up by the siphon-like action of the outlet thread makes itself felt, and there is a regular current in the direction of the arrows.

The front of the cell is formed of a piece of thin covering glass of $1\frac{1}{2}$ inch by $\frac{5}{8}$, and two small square blocks of glass I, cemented on each side, will hold this covering glass sufficiently firm to prevent it sliding on the organism and crushing it.

Such a growing slide will hold about 1 drachm of water, and taking the rate of the drops from the outlet thread as about one per minute, the whole of the water in the cell is changed once in an hour, while at the same time the current is not sufficiently strong to carry away more than the finest and lightest bodies. It allows of fair observation with a $\frac{1}{4}$-inch objective, and if desired could be made with thinner glass, so that a $\frac{1}{6}$-inch or $\frac{1}{8}$-inch might be used.

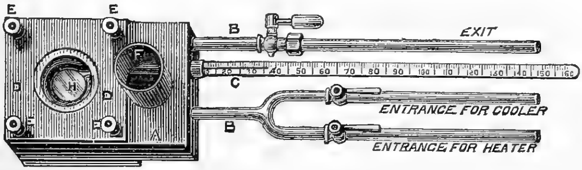
III.—*On a Hot or Cold Stage for the Microscope.*

By W. H. Symons, F.R.M.S., F.C.S.

(*Read* 14*th December*, 1881.)

This stage consists essentially of a copper or brass box A, Fig. 2, 8 cm. long, 5 cm. broad, and 1·5 cm. deep; an open tube F, 5 × 2 cm., communicates with the interior, and allows of the expansion of the contents and for filling. In the upper and lower sides of the box are apertures H, for the passage of light, 2 cm. in diameter, the lower covered by a thin glass cover, 2·5 cm. in diameter, and the upper by one which constitutes the working stage, 3·5 cm. in diameter. Both covers are kept in position

Fig. 2.



between pairs of vulcanized rubber rings by means of brass plates D, clamped on with screws E, the plates being furnished with apertures slightly smaller than the thin covers. A thin copper pipe B B, 5 mm. in diameter, is carried round the bottom of the inside of the box A, one end being forked, and all three branches furnished with taps. This pipe serves to convey the heating or cooling agent to the water or other liquid contained in the box.

The temperature is ascertained by means of a thermometer C, having its bulb bent in a circle slightly smaller than the aperture for light; it is placed in the box with the bulb almost touching the upper thin glass cover. Between the thermometer and the copper pipe is a copper partition, having a number of slots in its base to allow of the circulation of the water. In this way the thermometer is protected from undue heat, and as all water which reaches the upper thin glass must pass it, a very near approximation to the temperature of the object upon the thin glass is obtained, especially if the object is protected from currents of air by a cardboard shade.

The most convenient heating agent is steam, a small flask 100 c.c. capacity will work for over an hour, and the temperature may be varied from normal to 95° C. at pleasure; steam, however, gives out its latent heat immediately on coming in contact with the tube, and therefore that portion of the box or bath nearest to the supply becomes warm very much sooner than that further from it; if great exactness be required steam can be replaced by a current of warm water or saturated solution of chloride of calcium, which give out only specific heat, and that nearly equally through the whole length of the tube. In either case the box is filled with recently boiled distilled water or a saline solution, and placed, with a non-conductor intervening, upon the stage of the Microscope, so that the optic axis corresponds with the centres of the apertures; one of the forked tubes is then connected with the hot fluid, the other with a supply of ice-cold water, and the exit end of the copper tube with an empty vessel. The object is now placed upon the thin glass stage, covered with another thin glass, and surrounded with a cardboard shade and focussed. The heating agent is circulated through the copper pipe until the required temperature is attained, the tap can be then turned off, and if a sudden reduction of temperature be necessary the tap which communicates with the cold water turned on.

If a temperature above the boiling-point of water be required, the box is filled with glycerine, and the heat from a spirit-lamp conveyed to it by means of a projecting copper plate, one end being in contact with the bottom of the box, the other in the flame of the lamp. In this way any ordinary temperature can be obtained, but it is not so completely under control as the steam, there being a rise of some 10° after removing the source of heat.

If a very low temperature is wanted, all the metalwork is covered with felt, and the box filled with clean crystals of ice and salt and water.

This stage is specially adapted for those cases where a rising or falling temperature is required. It was originally contrived for studying the tumefaction of starches, noticing the temperature at which the various granules burst, but I have found it useful also for ascertaining roughly the melting-points of fats, by observing when the crystals in them disappear; and for jellies, resins, and other structureless, easily fusible, substances, by noticing when small particles assume the liquid form; and it will obviously have many other applications.

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.

Photographs of the Developmental Process in Birds.† — C. Kupffer and B. Benecke give fifteen photographic plates of the embryos of birds, with full descriptions, the outlines of the photographs being drawn on transparent paper, on which the necessary lettering is placed. A full description of the photographic apparatus is given, and it is stated that osmic acid was found to give to the embryos a colour suitable for photographic reproduction. When whole embryos are reproduced, the amplification is ten, and when one or other end only is photographed, it is twenty times. Some of the photographs are particularly good, and the tracings form admirable diagrammatic representations of the different relations of the parts. An important fact to which attention is drawn is, that within the limits of one species variations have been found to be much more marked in the earlier than in the later periods.

Development of the Paired Fins of Elasmobranchs.‡ — Mr. F. M. Balfour states that in *Scyllium* these arise as slight longitudinal ridge like thickenings of the epiblast, and that in *Torpedo* the anterior and posterior are on either side transitorily connected together by a line of columnar epiblast cells. Later on, the fins become a ridge of mesoblast covered by epiblast; the embryonic muscle-plates grow into the bases of the fins, and form two layers, while in the intermediate indifferent mesoblast changes begin to be set up, which give rise to the cartilaginous skeleton. There is thus formed in the fin a bar which springs at right angles from the posterior side of the

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

† Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. i. (1879) pp. 149–96 (1 pl. and 15 photos.).

‡ Proc. Zool. Soc. Lond., 1881, pp. 656-71 (2 pls.).

pectoral or pelvic girdle, and runs parallel to the long axis of the body. The free end of the bar begins to undergo segmentation into rays, and much of this is effected "before the tissue of which the plates are formed is sufficiently differentiated to be called cartilage by an histologist."

We have then a longitudinal bar along the base of the fin, which gives off perpendicularly a series of rays which pass into the fin. It is pointed out that, from its position this basal piece can never have been a median axial bar with rays on both sides. The resemblance to the arrangement of the unpaired fins is consequently very striking, and support is given to the author's original doctrine of a once continuous lateral fin.

Development of the Sturgeon.*—In continuation of his previous paper, Professor W. Salensky points out that in this fish it is very difficult to fix the limits between the period of the formation of the embryonic layers and that in which there appear the earliest rudiments of the organs. Here we find that the envelopment of the inferior by the superior portion, and the further differentiation of the embryonic layers is contemporaneous with the appearance of some of the organs in the mesoblast. Dealing with the modifications undergone by the egg up to the point at which the medullary groove becomes closed, the author states that organs begin to appear at the termination of the first day of development. On the second day a groove 0·7‴ in length appears in the middle of the embryonic area. The posterior extremity of this groove corresponds exactly to the blastopore. In the next stage the anterior end of this primitive groove dilates to form the rhomboidal rudiment of the brain. The hinder part of the groove opens directly into the primitive digestive cavity by means of the blastopore, and it is only near the end of the period of development that the union between the digestive and medullary cavities ceases to exist. Meantime, the lateral parts of the embryonic area have been undergoing important changes. On either side there appears a white band which behind diverges slightly from its fellow. These are the first indications of the Wolffian ducts; and the parts internal to them become modified to form the vertebral plates, and those external to them the lateral plates.

Previous, however, to the appearance of the groove on the surface of the embryonic area, important changes have been taking place within. There has appeared an axial thickening, formed from the ectoderm and mesoderm, which has an intimate connection with the formation of the notochord and of the central nervous system. These changes are described in detail. The mesoderm becomes divided into a median and lateral portions; the first constitutes the notochord, while the side pieces give rise to various organs. After the appearance of the medullary groove we may distinguish a central portion in which the groove is placed, and lateral parts which are distinguished by having over them the enveloping lamella. The bases of the cells which form the floor of the groove are strongly pigmented, and this

* Arch. de Biol., ii. (1881) pp. 279–341 (4 pls.).

pigment is derived from the ectodermal cells which become confounded with the cells of the medullary plates.

The further development of the nervous system consists in the progressive development of the lateral pieces which correspond to the medullary plates of other Vertebrates. At about this stage the parts of the mesoderm give rise to the excretory organs.

After the medullary groove becomes closed it is possible to distinguish a cephalic from a trunk region, and the boundary between the two corresponds to the anterior ends of the Wolffian bodies. Owing to the transparency of the embryonic area it is possible to see that the trunk grows by a gradual increase in the number of the primitive segments. Having before had five somites, we see these last increase as changes go on in the form and position of the blastopore. While the anterior segments retain their perpendicular position, the posterior become inclined to the longitudinal axis, to return later on to their primitive position. While elongation is proceeding, the trunk becomes thicker, the dorsal region increases in size, and there is exhibited a slight inclination to the right, the appearance of which causes a certain asymmetry in sections taken at this period.

Soon the blastopore closes, and its position is marked by an accumulation of pigment. The rudiment of the tail becomes visible by the formation of a tubercle; the cephalic extremity possesses two vesicles, and the mesoderm is still thin anteriorly. Where the cephalic plate enlarges, a central and a peripheral part may be distinguished, the branchial clefts begin to appear, and a facial process is developed in front of the head. The heart does not commence to contract till the end of the period of embryonic development, and its contractions are at first very slow. Simultaneously with this the veins and their ramifications appear.

The author next proceeds to a study of the development of the internal organs with which he considers the modifications of the embryonic layers. He points out that the ectoderm consists of two layers, of which the superior is, at first, strongly pigmented; throughout its development its cells nearly all retain their original flattened character; the lower layer is that which contributes most largely to the formation of the sensory organs in which, except in the case of the olfactory fossæ, the outer layer takes no part. After describing the details of the development of the central nervous system, Professor Salensky raises the question of the homology of this region with the nervous system of Vermes and Arthropoda. He points out that (1) the central nervous system of all Vertebrates is formed from two thickenings of the ectoderm, set parallel to the long axis of the body: that of all Articulates has a similar origin. (2) In some cases, e. g. *Echiurus*, the "Articulates" present a median groove comparable to that of Vertebrates. (3) The formation of the medullary groove commences, in the case of both phyla, posteriorly, and is continued forwards. On the other hand the Vertebrata have the central nervous system dorsal in position, and the medullary groove becomes closed. As to the first of these, he points out that the position of the mouth is the determining character, in conjunction with that of the locomotor organs; these points he looks upon as having less morphological value than the development of the system, and its correlation with other organs during the course of development. The closure of the medullary groove is regarded as being merely the result of further modifications.

If we accept the general homology, we have next to determine how the parts correspond; the author cannot follow Dohrn and Hatschek in regarding the homology as being complete; he looks upon the brain of Vertebrates as being a new formation, which is their exclusive property; it merely consists in an elongation and dilatation of the already existing nervous system, or in other words the medulla, which is the analogue of the ventral ganglionic chain of the Articulata.

The mesodermal derivates are dealt with in great detail, and a comparison with what is seen in Plagiostomi leads the author to say that they approach the higher, while the Ganoids approach the lower Vertebrata; and this portion of the essay concludes with an account of the development of the enteric tract.

Development of Petromyzon Planeri.* — J. P. Nuel directs attention to the phenomena of the contractility of the ovum: immediately after impregnation, before which the vitellus was everywhere closely applied to the chorion, the yolk commences to contract, till at last it is at all points separated from its investment. Calberla regarded this as being due merely to osmotic action, but the fact seems to be that a contractile wave, starting from the active pole, slowly but gradually passes over the whole of the yolk; this takes about twelve minutes to be effected.

From the moment when the egg begins to segment there is a period of rest between each division, and this period shortens as development advances; when the segmentation period is at an end the cells of the hypoblast are in repose for a lengthened period, while the epiblastic cells, continuing to divide, give rise to an epibolic invagination. At a certain period most of the hypoblastic cells start into activity, and the elements of the digestive tract begin to be formed; some of them, however, still remain quiet, and, only later, give rise to the liver. When a group of cells enter into activity, their calibre diminishes, and the yolk-grains are fused together.

After describing the details of the development of the digestive tract, M. Nuel states that the transformation of the yolk-spheres first takes place along the axis of the embryo; commencing at the anus of Rusconi, it rapidly extends forward; being most intense at the point where the epiboly is most advanced; thence it widens out, and gradually invades the whole surface of the hypoblast, till it comes into contact with the segmentation cavity.

When the mesoblast developes, it is clear that it has no relation to the *chorda dorsalis;* for the two are simultaneously differentiated from a common embryonic layer, which, later on, also gives rise to

* Arch. de Biol., ii. (1881) pp. 403-54 (2 pls.).

the secondary hypoblast; the mesoblast in *Petromyzon*, just as in the Sturgeon (Salensky) is developed from behind forwards.

The chapter on the germinal layer is largely occupied with a criticism of the observations of W. B. Scott; and the author concludes by giving his adhesion to the doctrine of His, that the study of the mechanical causes which affect the embryo, and the causal connection of the changes which take place in the egg are the true objects of embryology, and he points out that this side of the study is to descriptive embryology what physiology is to zoology.

White Corpuscles of the Blood.*—M. Renaut describes the different forms presented by the white corpuscles in different animals. In the Crayfish, besides the ordinary lymph-corpuscles, there are many larger bodies with well-defined nuclei, the protoplasm of which contains large highly refracting granules, resembling in many respects the vitelline granules of the Frog and other Batrachia. These corpuscles have a sharply limited, but thin exoplastic pellicle; and if a drop of such lymph be allowed to fall into a drop of a 1 per cent. solution of osmic acid, the white corpuscles are instantly fixed, with their pseudopodia or protoplasmic processes extended; and these processes can then be seen to perforate the thin membrane, now blackened with the acid. There are thus two kinds of white corpuscles in the Decapod Crustacea—the lymphoid corpuscles and the amœboid corpuscles.

Do similar differences exist in the blood of Vertebrata?

In reply to this, M. Renaut states that in the blood of all the Vertebrata, from the Cyclostome to the Saurians, the white corpuscles are of two kinds; one, the ordinary white corpuscle, composed of hyaline protoplasm, presenting many short projecting points, with a nucleus undergoing gemmation, and sending forth branched pseudopodia when placed under favourable conditions; the other containing numerous brilliant granules imbedded in the protoplasm and surrounding the nucleus. These resemble the second form of corpuscle described above as existing in the lymph of the Crayfish, but differ from them in having no outer limiting layer of condensed protoplasm, or exoplasm, as Haeckel has named it. The application of osmic acid shows that they may be subdivided into two other forms, one closely analogous to cells undergoing transformation into fat-cells, which present numerous granules, and stain black with osmic acid, and another set which contains granules that are not fatty, but which stain red with eosin. The best mode of demonstrating the existence of these three forms is to fix the blood in the rete mirabile of the capillary layer of the choroid in the posterior segment of the eye of a frog, by removing the anterior segment and exposing it to the vapour of osmic acid. At the expiration of twelve hours the eye is removed from the vapour, washed, the chorio-capillaris detached from the retina, and spread on glass; it is afterwards coloured with, and mounted in, hæmatoxylate of eosin. The corpuscles may then be studied, and the three forms of ordinary, granular, and fatty corpuscles can be easily distinguished.

* 'Science,' ii. (1881) p. 505, from 'Arch. de Physiol.' and 'Lancet.'

M. Renaut finds that the white corpuscles of mammals generally, and of man in a state of health, all closely resemble each other, and are of the ordinary kind; but in disease, as in leucocythæmia, the white corpuscles are not only greatly increased in number, but vary considerably in size. Moreover, they are round, and present no pseudopodia. They are hyaline, and have a smooth, well-defined limiting membrane, and some of them have nuclei which have undergone fission, just as in a cell that is about to segment. Hence, he is of the opinion that the white corpuscles multiply and increase in number while floating in the blood; other corpuscles may be observed, which are charged with granules of some proteid substance, resembling vitelline granules, or small masses of hæmoglobin; and, lastly, there are still other cells, which are charged with fat. M. Renaut has made some observations on the development of the red corpuscles of the Lamprey, and gives the following succession of forms. White corpuscle with nucleus proliferating and protoplasm not limited by an exoplasmic layer; corpuscle with nucleus proliferating, the protoplasm forming an uncoloured disk, limited by an exoplasm; corpuscle with proliferating nucleus, protoplasm limited by an exoplasm, and forming a disk, more or less charged with hæmoglobin; red corpuscle with proliferating nucleus; and finally, circular red corpuscle, with rounded nucleus.

Nerve-endings of Tactile Corpuscles.*—W. Krause discusses the different views which have been held as to the condition of these nerve-endings, viz.:—(1) Langerhaus, who considers that the fibres divide di- or trichotomously after entering the corpuscle, and end thus by only two or three terminal twigs which may be flattened into terminal disks, as is generally the case in the end-bulbs, and especially in the round ones. (2) Ranvier, who states of the laminar terminal corpuscles of the tongue of water-birds, &c., and of the laminar tactile corpuscles, that a terminal disk is interpolated between every two of the cells which lie transversely in the bulbs. Krause obtained similar results by the use of formic acid and chloride of gold. (3) Meissner, from pathological and other observations, has set down all the transverse striation to nervous structures, except some possibly due to nuclei. But Krause, supported by Fischer and Flemming, has explained the large number of transverse nervous terminal fibres as due to a spiral course of the latter, accompanied by repeated dichotomous branching.

In order to reconcile the three views, it may be held that Langerhaus' opinion applies to some of the smallest and simplest corpuscles; while Ranvier's apply to their larger and more usual forms; whereas Fischer's preparations show the course taken by the terminal fibres in reaching their disks. Krause himself holds the inner bulbs to consist of transverse bulb-cells with pale terminal nerve-fibres ending in knobbed or discoid terminations between them.

* Arch. mikr. Anat., xx. (1881) p. 215 (1 pl.); and Biolog. Centralblatt, i. (1881) pp. 462–3.

Distribution and Termination of Nerves in the Cornea. * — Opinions have differed widely as to the actual mode of termination of the corneal nerves, whether singly or by fasciculi in the corneal cells, or by reticulations surrounding them. These and kindred questions have been investigated by Professor G. V. Ciaccio. He has studied animals from all the Vertebrate classes except fishes, and has chiefly employed chloride of gold to render the nervous elements visible. His results are summed up as follows:—

1. The nerves of the cornea are of different kinds and have different functions, viz. (*a*) sensitive, some to light and some not, and (*b*) trophic, regulating the nutrition of the tissue.

2. They form a plexus, the "circumferential nervous plexus", at the circumference of the cornea before entering it; this consists partly of medullated, partly of non-medullated fibres.

3. This plexus sends out branches and twigs of different sizes in various quantities, which enter the cornea, divide and subdivide there and form a plexus, the "primary or principal nervous plexus," which traverses its entire breadth; in the rabbit, mouse, rat, and bat it lies chiefly near the anterior face; in lizards, tortoises, frogs, and tritons it is near the middle of its thickness; in birds it is mostly contained in its anterior portion.

4. Other plexuses exist in this organ, more or less derived from or dependent on this chief one; they are termed secondary or accessory; they sometimes lie above, sometimes below the chief one. In the frog this plexus lies below the latter, and close to Descemet's membrane; in the mouse, it lies above, close to the anterior face of the cornea and thus constitutes the "subbasal plexus" of Hoyer and others.

5. The principal plexus gives off a large number of small branches, sometimes accompanied by ultimate fibres; they are termed "perforating branches"; they break up first below the epithelium, each into a tuft of fibrils, which form between themselves the "subepithelial plexus," of greater or less closeness, and differently arranged in different animals. In the mouse and rat, and perhaps the bat, it has a concentric arrangement, but the centre does not correspond to that of the cornea.

6. From different places in the subepithelial plexus fibrils go off and enter the epithelium, dividing and anastomosing, and thus forming in it a very delicate reticulation, probably broken off here and there, (the intra-epithelial rete or plexus of modern authors); the fibres terminate either in small button-like dilatations or simply below the outermost cells of the epithelium, which form a delicate membrane interposed between these endings and the exterior.

7. The various plexuses and networks thus formed are not to be considered as so many distinct units but as so many compound systems, each of them being made up of as many parts as there are nerves entering into its constitution. Thus, by their distribution over the cornea, the nerves form just so many anatomically and physiologically distinct regions as there are trunks and branches of nerves.

* Mem. Accad. Sci. Ist. Bologna, ii. (1881) 24 pp. (2 pls.)—Sep. repr.

8. The nervous fibres, both those of the proper substance of the cornea and those of its epithelium, always terminate in two ways, namely, by plexus or reticulation and by free ending. The latter mode, when occurring within the cornea, takes place not only in the branching cells but also within or between the fibrous laminæ.

9. The axis-cylinders of the corneal nerves are made up, like the fibres of striated muscle, of fibrils, each of which consists of minute particles and of a peculiar intermediate substance which unites them in linear series; in this case these particles are round, whereas in muscle they are prismatic.

Influence of Food on Sex.*—The results of experiments detailed by E. Yung tend to confirm those previously obtained by G. Born,† who found that when young tadpoles were subjected to special kinds of food (in one case vegetable food being given, in another mixed vegetable and animal), a large preponderance of females were developed. In these experiments there was an absence of what forms the chief normal food of tadpoles, viz.—marsh-slime, containing various organic detritus, rotifers, infusoria, diatoms, &c.

Yung reared the tadpoles of *Rana esculenta* in four vessels, feeding the broods respectively on fish, meat, coagulated egg-albumen, and egg-yolk. The percentage of females in each case was 70, 75, 70, and 71. In a fifth vessel, out of a brood of 38 tadpoles nourished simultaneously on meat, algæ, and white of egg (without slime), 30 were females, six males, and two doubtful. These results seem to demonstrate that the quality of the food experimented with exercised no distinct influence on the sex, but that a special diet given to young tadpoles from the time of hatching favours the development of a female genital gland, as Born concluded.

B. INVERTEBRATA.

Mollusca.

Digestion of Amyloids in Cephalopoda.‡—E. Bourquelot in attempting to resolve the contradictory statements that have been made with regard to the presence of a diastatic ferment in the liver of the Cephalopoda, finds that the quantity of starch which is altered varies with the condition of the individual. When it is starving the action is slow and difficult to detect, for the gland is then in repose; but when digestion is going on in the animal the change is almost instantaneous. As in mammals, ruptured starch-grains are alone acted on. It is somewhat curious, the author thinks, to find this ferment in carnivorous animals, but its presence affects the discovery of the possible glycogenic function of the Cephalopod's liver. Can glycogen and starch-ferments exist in the same gland? as yet there is no proof of the presence of sugar in livers that have been properly treated, but, as the author justly remarks, in physiological chemistry an experiment yielding negative results should be frequently and carefully repeated.

* Comptes Rendus, xciii. (1881) pp. 854–6.
† See this Journal, i. (1881) p. 874.
‡ Comptes Rendus, xciii. (1881) pp. 979–80.

Proneomenia sluiteri.*—Dr. A. A. W. Hubrecht gives a full anatomical account of this interesting archaic Mollusc, the discovery of which we have already noted.† There are no external appendages; the groove enclosing the foot is indicated by a dark longitudinal line, the mouth and anus are at either extremity. The integument is stiff owing to the presence of several layers of spicules of carbonate of lime; externally to the circular layer there is a cellular one, which appears to be the matrix of the integument; and there is an interspicular substance which is homogeneous and structureless, and appears to be of a chitinous nature. The youngest spicules are found quite close to the deep cellular layer of the matrix; the older ones are in communication with this layer by radiating cords of connective tissue, and the points of the innermost project towards the exterior. So far there are certain important differences between this form and *Neomenia*, and, in the latter, blood-vessels find their way into the skin; moreover, in *Proneomenia* at the hinder end of the body there are two symmetrically developed cæca connected with the anal cavity, and containing a special secretion; they are provided with a strong muscular investment, so that, whatever their homology or functions may be, there can be no doubt that at times their contents may be forcibly expelled.

In his account of the muscular system the author states that in *Proneomenia*, as in *Neomenia*, the stronger muscular fibres are enclosed in a delicate sheath of connective tissue, which forms transverse folds and so gives to the muscle the appearance of being striated. The most anterior portion of the ventral groove leads into a system of ciliated slits and cavities which ramify and communicate with one another; the whole would seem to form a gland—the "anterior foot-gland." The posterior foot-gland has no ciliated cavities.

The nervous system truly belongs to the type of the *Amphineura;* the single cephalic ganglion is comparatively very small; it gives off three separate pairs of principal trunks, the innermost of which forms, as in *Chiton*, a sublingual commissure; the second pair surrounds the pharynx and developes the anterior pedal ganglia; the third pair gives rise to the longitudinal lateral nerves, and "a regular series of commissures similar to those between the two pedal nerves, connect the two lateral with the two pedal nerves." The study of the details of the nervous system reminds Dr. Hubrecht that all late investigations into the lower Invertebrates appear to point towards an increased complication of the commissural connections, culminating in the direct continuity of nervous tissue throughout more or less extensive regions of the body. It is remarkable further, that "the lower we descend in the Molluscan subdivision the more a system of transverse commissures between the longitudinal connective stems fixes our attention." Perhaps, indeed, the earlier Mollusca had their nervous system plexiform in arrangement. Further, the fact is of

* Niederl. Arch. f. Zool., Suppl. Band I., ii. (1881) 75 pp. (4 pls.).
† See this Journal, i. (1881) p. 28.

importance that the primary nerves are accompanied by a layer of nerve-cells.*

The digestive system is divisible into a muscular buccal mass, a ciliated intestine and the rectum; the pharynx possesses a number of radial folds, and there is an inner coating of a yellowish chitinous cuticle. No trace of a radula is to be seen in *Neomenia*, but in *Proneomenia* it is interesting to observe a muscular process representing the tongue and invested in chitin; salivary glands appear to be present. The intestine is uniform throughout, with thin walls, provided anteriorly with a cæcum; the lumen is obstructed by the deep transverse folds, found in this form and its allies, and there are indications of an incompletely differentiated liver, in the form of secreting cells on the lateral portions of these laminæ.

The generative system is perfectly symmetrical, and consists of the germ-gland, which is situated along the whole length of the body, and is dorsal, and of the different cavities and canals found at the hinder end of the body. The general type in the Solenogastres appears to be the possession of a double genital gland which communicates with the pericardium; from this a complex of ciliated and glandular ducts leads towards the exterior, to which it opens in the region of the anus. The author thinks it possible that part of the conducting tubes of the genital system represent the kidney. If this view is supported, we shall find in *Neomenia* a form in which the genital products are discharged by a pair of ducts into the body-cavity (pericardium); thence they are conducted by paired ciliated ducts into the cavity of the kidney; in other words, we have indications of a more primitive stage in which the cavity of the pericardium was the meeting-point of the efferent ducts of the genital glands, and the excretory ducts of the renal organ.

The circulatory system is almost completely lacunar, the heart is more or less saccular in form, and as radiating fibres traverse its cavity, it has a resemblance to the embryonic heart of some higher Gastropods: it is possible that the blood-corpuscles contain hæmoglobin. There appear to be no branchiæ at the posterior extremity of the body. The paper concludes with a detailed comparison of this form with *Neomenia* and *Chætoderma;* and of the Solenogastres generally with the other division of the Amphineura—the Polyplacophora.

Molluscoida.

Development of Salpa.†—Professor W. Salensky has a preliminary communication on this subject, to which his attention has been compelled by the different results obtained by Brooks and Todaro, as compared with those of his own earlier investigations. He now finds that there are great differences between the *S. democratica* which he previously examined, and the *S. pinnata*, which was the subject of Todaro's studies. In all species of *Salpa* the ovary is found at the hinder end of the body, and consists of an egg-cell, enclosed in a

* We may observe that Balfour has noted a number of commissures between the ganglia, and a ventral ganglioniç layer in the ventral cords of *Peripatus*.

† Zool. Anzeig., iv. (1881) pp. 597–603, 613–19.

follicular capsule; this follicle has a solid stalk, which leads into the oviduct; where the wall of the respiratory cavity is connected with this, it is thickened, and the projection so formed was taken by Todaro for the uterus; the maturation of the ovum is always accompanied by the shortening of the stalk, till the follicular cavity becomes connected with the oviduct. After this impregnation takes place.

In further development differences obtain between the species as to the form of the embryo, of its coverings, and of the number of follicular cells. Considerable differences are seen early between *S. democratica* and *S. bicaudata;* the former has no amniotic fold, the latter lies in a prolongation of the body, formed from the cellulose-mantle, blood sinuses, and a tubular continuation of the wall of the respiratory cavity. The first signs of the differentiation of the central mass is the separation of the lower wall of the follicle, and a cavity is thus formed which the author proposes to call the follicular cavity, instead of applying Todaro's unsuitable term of cleavage-cavity; this wall becomes the upper wall of the placenta. In *S. pinnata* the nervous system arises in the form of a tube with an at first narrow lumen. In the other species the ganglion has the form of an aggregate of cells, derived from the follicular cells. From the connecting canal between the enteric and neural cavities we have formed a ciliated pit. An account is given of the formation of a special organ known as the subpericardial aggregate of cells; Uljanin has informed the author that a similar structure is to be observed in *Doliolum.* The elæoblast is formed from the amœboid follicular cells which give rise to the blood-corpuscles and muscles.

The author insists on the great differences between the developmental history of *Salpæ* and that of other animals, the organs being formed not from the cleavage, but from the follicular cells; something similar has, however, been noted in the allied *Pyrosoma;* and, instead of speaking of development of *Salpæ*, he would prefer to give the process the name of follicular gemmation.

Tunicata of the 'Challenger.'* — In a fourth communication Dr. W. A. Herdmann deals with the Molgulidæ, and describes *Molgula pedunculata, horrida, forbesi,* and *pyriformis, Eugyra kerguelenensis*; *Ascopera* is a new genus with a pyriform, more or less pedunculated body, the test thin, while the branchial sac has seven folds on either side: *A. gigantea* and *A. pedunculata.*

Arthropoda.

α. Insecta.

Striated Muscle of Coleoptera and its Nerve-endings.†—The main results obtained by Professor L. v. Thanhoffer on this subject show the striated muscle of Coleoptera to possess two separate sarcolemmar membranes, between which the nerve-ending plate spreads

* Proc. Roy. Soc. Edinb., 1881, pp. 233–40.
† Biolog. Centralblatt, i. (1881) pp. 349–51.

out, the axis-cylinder of the nerve dividing dichotomously, and the nerve forming a reticulum in the plate. In the Frog no such reticulation is formed, but the divisions of the axis-cylinder come into contact with the nuclei which overlie the muscle-fibre. In the beetle the nerve-substance of the plate is separated from the muscular substance by a membranous structure which is connected with Krause's transverse lines. Strong contraction, produced by electricity, causes resolution of the transverse lines of the muscle into molecules; but fine striæ, due to the approximation of Krause's lines, are still to be seen, except after very violent contraction. All the described forms of cross lines can be seen in the Coleopteran muscle. The outer sarcolemmar sheath is in connection with the outer sheath of the tendon; a reticular lymphatic canal-system ramifies from the latter and terminates in the uniting substance of the fibrils, showing cell-like granular structures at the points of division.

These canals show connective-tissue cells bearing processes shaped like windmill-sails at the point of insertion of the tendon. The main nerves of the muscles lie in special "perineural" cavities, lined with a multilaminar sheath. Isolated muscular fibres of *Hydrophilus piceus*, connected with end-plates, show the Krause's lines next to the membraneous neural septum to be in close apposition, whereas towards the sides they become gradually more distant; they appear to converge towards the plate when near it, but to diverge when remote from it.

Terminations of the Motor Nerves in the Striated Muscles of Insects.*—H. Viallanes has studied the mode of termination of the nerves in the muscles of the larvæ of *Stratiomys chamæleon* Macq. and *Tipula gigantea* Macq., and finds that in both the muscular fibre is on the same plan as that of Vertebrata; and consequently differs greatly from that of adult insects, which is histologically distinct. The results which he obtained cannot therefore be compared with those obtained by most of his precursors, who studied chiefly adult insects.

In *Tipula* each muscular fibre receives only a single nerve, and has only one Doyère cone: but in *Stratiomys* each receives several nerves, and has several Doyère cones.

The sheath of the nerve continuous with the sarcolemma constitutes the wall of the Doyère cone.

The axis-cylinder having penetrated to the summit of the cone divides into two principal branches, which give off secondary branches; these again divide dichotomously a great number of times. There results a terminal nervous plexus beneath the sarcolemma, and comparable to that in the Vertebrata. The author claims to have been the first to point out such a plexus in other animals than Vertebrata.

This plexus occupies a considerable area in *Tipula;* but is much reduced in *Stratiomys.*

As in the Vertebrata, all the branches of the plexus are situated between the sarcolemma and the contractile mass; they seem to terminate in a slender point as in the frog.

Special nuclei are adherent to the branches of the plexus, and

* 'Thèse pour le Doctorat en Medicine,' 8vo, Paris, 1881 (45 pp. and 3 pls.).

accompany them throughout their course. These the author calls "nuclei of the plexus" (*noyaux de l'arborisation*), comparing them to those so named in the Vertebrata.

In *Tipula* there is attached to the principal branches of the plexus a granular substance provided with special nuclei, which must be compared to the "fundamental nuclei" and "granular substances" of the plexus of the higher Vertebrata. They are completely wanting in *Stratiomys*.

Between the plexus of *Stratiomys* and *Tipula* there exists a difference analogous to that observable between the plexus of the frog and that of the lizard.

These results do not necessarily invalidate, the author says, those of Ranvier and Foettinger, because he has dealt with a histologically different matter. They confirm, however, the observations of Rouget, who has described the axis-cylinder as forking in the interior of the cone, the two branches of the fork being applied to the surface of the contractile mass but not appearing to extend further. They also confirm his view that the granular matter which fills the cone is of little importance, being absent in *Stratiomys*.

Wings of Insects.*—Dr. G. E. Adolph figures a large number of wings chiefly of Hymenoptera, and points out that the arrangement of the concave and convex lines is the most constant character, but that the concave are much more persistent than the convex. A study of the arrangements seen in *Vanessa* has shown him that the tracheal system of the wing is first developed along certain primary lines, the most primitive and striking peculiarity of which is their tracheal nature; between these there are developed certain costal elements. After dealing with the Lepidoptera he passes to the Diptera, and in their case, as in that of the Neuroptera, he institutes a comparison with the Hymenoptera, pointing out how fresh branches become developed and earlier nervules absorbed.

In a second paper † he deals with certain abnormal developments in the wings of some *Hymenoptera*.

Structure of the Proboscis of Lepidoptera.‡—W. Breitenbach, dealing with the phylogeny of this organ, finds in the early stages of the insect indications of its origin, for in the late larva it has been found already represented by two long curved cords. But further, the obvious connections of the group with the Trichoptera show that the biting mouth of the latter has produced the sucking tube of the former by modification of the labium, maxillæ, and labrum, which were at first all united into a tubular organ; the edges of the two maxillæ then became more closely approximated, and the share of the other two parts in the organ became unnecessary, and they were excluded from it. This metamorphosis, however, was probably made in various stages, each having some definite advantage to the insect as its object: e. g. the exclusion of the labrum and labium from the organ was a

* Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 213–92 (6 pls.).

† Tom. cit. pp. 293–328 (1 pl.).

‡ Jenaisch. Zeitschr. Nat., xv. (1881) pp. 151–214 (3 pls.).

beneficial simplification, the great object being to bring the two maxillæ together; the latter organs were able to assume a greater development in consequence of the reduction of the former; this development was further promoted by the abnormal method by which food was obtained. The increase in the length of the tube was caused by the depth which the nectaries of certain flowers exhibited, and by which they excluded insects hurtful to them, while, at the same time, this very depth allowed of the accumulation of a greater amount of honey.

The transverse striation of the tube, noticed by Réaumur, is produced by semilunar bands of chitin, which are set side by side from the root to the extremity of each half-tube in two series of half-hoops, exterior and interior; the degree of their development varies in different insects; they are most slender at the apex, a fact which is partly due to the space occupied by certain papilloid processes on this part. The form of the bands also varies; in some Lepidoptera they are broken up into a series of separate chitinous pieces; sometimes, as Gerstfeldt has observed, they are forked, but in this case they are divided only into two arms, not three, as stated by that observer. The transition from the condition in which the bands are composed of series of separate pieces to that in which they form continuous strips is well seen in passing from *Pieris* to *Vanessa*, though even in the latter genus (e. g. *V. cardui*) the transverse chitinous series are not wholly united into bands. It is uncertain whether the disconnected or the consolidated form of the chitinous bands of the tube is the primitive condition. The apposed edges of the two halves of the tube may be either serrate (*Egybolia*) or plain (*Argynnis*).

The *apex* of the proboscis presents, as already well known, certain organs called juice-borers. The simplest form of these is (1) that of simple hairs, which occur on every proboscis, and consist of a basal chitinous ring, the "cylinder," and a true hair-shaft, which is traversed by a horny mass, the "axial radius," termed "central mass" in the juice-borers; the cylinder is usually imbedded in the main substance of the tube. When true sap-borers coexist with them, the hairs are short, and *vice versâ*. The varieties in form of the juice-borers are caused by varieties in the peripheral portion of the shaft. 2. Juice-borers, with the upper edge of cylinder dentate, e. g. *Vanessa*. Cylindrical or barrel-shaped, the teeth are six to eight in number, moderately sharp; in *Pyrameis virginiensis* they are cylindrical, laterally compressed. 3. Juice-borers with longitudinal ridges formed by the chitinous covering of the "central mass" which spreads out into six plates, running parallel to its axis, e. g. *Catocala*, *Noctua*, *Plusia*, *Mamestra*, *Agrotis*, *Triphæna*, *Phlogophora*, *Tæniocampa*, *Euclidia*, &c. 4. Juice-borers of *Arge Galathea*. Upper surface armed with six teeth, and three similar whorls of teeth in succession below them, parallel to the first series; the points are directed towards the apex of the organ. 5. Unarmed juice-borers; e. g. those of *Argynnis*, *Melitæa*, *Ageronia Arete*, *Macroglossa*, *Hesperia*, *Taygetis Xanthippe*, *Heliconius*, *Eneides*, *Agraulis*, &c. 6. Juice-borers of *Scoliopteryx libatrix*. Of two forms. (*a*) A thick-walled cylinder, the edge armed with two blunt processes, the point of the central mass projecting between them, and armed with chitin. (*b*) as (*a*) but the point of the central mass prolonged to as great a length as the cylinder itself, or greater. 7. *Egybolia Vaillantina.* A very thick-walled cylinder, the central mass projecting by a small conical process from its extremity. A form allied to this is exhibited by an Australian moth, viz. a pointed cylinder, the central mass projecting from its side as a very small process. 8. Recurvate juice-borers. Recurvate hooks, calculated to lacerate the tissues when the proboscis is withdrawn from a soft vegetable mass into which it has been plunged; e. g. *Ophideres, Achæa chamæleon, Egybolia Vaillantina, Scoliopteryx libatrix.*

Functions of Juice-borers.—The object of obtaining supplies of juice is clearly that of the last form; that of the simplest forms must be sought in their origin from simple hairs, which must have been originally organs of touch; but, in spite of Fritz Müller's view as to the general prevalence of this latter function, they must be considered, from their structure and position, to be truly and solely instruments for extracting juices. The cases in which the structure of these organs is known are too few at present to base classificatory systems upon them, and in some cases they appear to be little adapted for such a purpose, as, for example, the form with longitudinal ridges (No. 3), which occurs in numerous European genera of each of the three groups, *Bombyces, Noctuæ,* and *Geometræ,* besides some genera of uncertain position. In the Micro-lepidoptera they have not been examined.

Internal structures of the halves of the proboscis.—The muscles consist of a main longitudinal band passing from base to apex, and of numerous small branches passing off obliquely from it, and attached on the upper side; the latter cause the tube to roll up by contracting first near its apex, and then in succession towards the base. The nerves are not known. A tracheal tube traverses each of the maxillæ, ending blindly at its apex.

The closing of the two halves, in a species of Sphinx, is effected by two different arrangements. The lower edges are joined by means of a pair of teeth in each half (as seen in transverse section), which interlock with those of the opposite half; on the upper side the integrity of the tube is effected by fine hairs and spines in the two halves, which cross and form a kind of joint. Similar arrangements appear to occur in some other forms. The act of sucking appears to be caused, not by exhaustion of air by means of the tracheæ, as would be the case if the method had an analogy with that of higher animals, but by partial separation of the two halves of the tube, causing attenuation of the enclosed air, and forming an imperfect vacuum, which thus allows the pressure of the external air to act on the juices of the flowers attacked by the insect.

Post-embryonic Development of Diptera.*—H. Viallanes, noting that of all insects the Muscidæ exhibit the greatest differences between

* Comptes Rendus, xciii. (1881) pp. 800-2.

the larval and the perfect state, has continued the investigations of earlier naturalists by a study of *Musca vomitoria*. When the larva becomes converted into the pupa, the skin of the whole of the body, and not only that of the head and thorax, undergoes degeneration of the hypodermic cells; and this is carried so far, that at one time the animal has nothing but a delicate cuticle covering it; the embryonic cells which fill nearly the whole of the body of a pupa are not all derived from the nuclei of the muscle-cells, some are formed by the proliferation of the cells of the fat-body. It is pointed out that the return of the tissues to the embryonic condition is the cause of the pupa having, at a certain time, really the characters of an embryo; if we make a section across the abdomen of a pupa between the second and fourth days we see that it is only composed of two layers of central cells, one formed from the epithelial cells of the digestive tube and the other, set peripherally, and formed by embryonic cells derived from the muscular nuclei and the cells of the fat-body. The imaginal disks seem at first to form a hollow sphere in which one part has been pushed into the other; the inner layer is thick, and made up of pyriform cells, the outer layer is delicate, and its cells flattened. Later on, the latter disappear, and the inner layer gives rise to the integument of the adult. The disks for the eyes are distinguished by having the cells of their inner layer regularly set side by side; they are cylindrical in form, and their inner extremity is pointed; by this they become connected with the fibrils of the optic nerve. The author finds that the integument of the abdominal region of the adult is formed by the conversion of the embryonic into hypodermic cells, the hypoderm first appearing, for each joint, at two superior and two inferior points. Further observations are promised which will deal with the metamorphoses of the nervous system.

Criticizing the statements put forward by Viallanes, Künckel* points out how the author's view, that the embryonic cells are partly formed by proliferation of cells of the fat-body, has been contradicted by his own observations and those of Ganin, which show this body to be no more than a reserve of nourishment, in other words, a post-embryonal vitellus. The buds which give rise to the integument of the head and thorax have been wrongly termed "histoblasts" by Viallanes, for they have not, as the term would imply, a common origin and common constitution, but give rise to the nerves, tracheæ, and the skin itself; their structure has been rightly elucidated by Ganin as that of small sacs filled with cells, and as having an exoderm and mesoderm. The development of the hypodermic cells, as already described by Ganin, is essentially the same as that described by Viallanes.

A justification by Viallanes of his statements is given in a subsequent paper,† in which he points out that Ganin regarded the hypodermis of the abdomen of the adult as being developed by transformation, while he has proved that there is a true degeneration of the cells.

* Comptes Rendus, xciii. (1881) pp. 901–3.

† Loc. cit. pp. 977–8.

Development of Adoxus vitis.*—M. Jobert has been studying the generation of this, next to *Phylloxera*, most dangerous enemy of viticulture. A smaller and a larger form are to be distinguished, but dissection shows that they are both females. A little above the point where the ovary joins the oviduct, a spermatheca opens by a duct; it forms a well-developed glandular organ without any copulatory pouch. Two long tubular glands also open into the vagina. The idea arises that the males died before the females came out, or that they do not resemble the females; however, the author was on no occasion able to detect the presence of spermatozoa in the copulatory pouch. One hundred insects were collected, of which 50 were dissected and found to be unimpregnated females; the others were kept alive and isolated. After some time they laid each from 25 to 30 eggs; two were immediately killed, and still found to be without spermatozoa. The eggs that were laid were fertile.

As against the theory of parthenogenesis we have to note the possibility of hermaphroditism, for at the moment of oviposition the tubular glands are well developed, and contain a mass of a refractive substance, which, when highly magnified, resolved itself into a prodigious quantity of vibratile rods, one-hundredth of a millimetre long.

Colouring Matter from the Willow-tree Aphis.†—Mr. C. J. Muller finds that the abdomen of *Lachnus viminalis*—an Aphis which feeds on the juices of the bark of the willow-tree—is filled with hard granules, like grains of sand variously coloured, green, red, and yellow. A gentle heat fuses them, and the fused mass on cooling exhibits under the polariscope all the characteristics of salicine. This is best seen by digesting the insects in pure benzole, the deep red solution then obtained being afterwards evaporated on a glass slide. The author considers that the colouring matter belongs entirely to the juices of the tree on which the insect feeds, and that it is not in any way manufactured by the Aphis (except in so far as animal heat and the digestive process may influence it), so that if this opinion is correct, it would account for Dr. Sorby not finding in the red Apple Aphis the physical and optical properties of the colouring matter of the Cochineal insect. The latter feeding upon a plant altogether different from the apple, the character of its colouring matter will necessarily differ.

γ. Arachnida.

Liver of Spiders.‡—Dr. P. Bertkau states that the gland which has been so called, lies in the hinder part of the body, where it is divided by the heart and intestine into two halves; in most species it completely invests the generative organs and spinning vessels. The gland is follicular in structure, the separate follicles being united into larger masses by the *tunica propria*. The cells are large and cylindrical, and they contain a quantity of large and smaller spheres,

* Comptes Rendus, xciii. (1881) pp. 975–7.
† Proc. Eastbourne Nat. Hist. Soc., 18th Nov., 1881 (6 pp.).
‡ Zool. Anzeig., iv. (1881) pp. 543–4.

the former of which lie near the lumen and the latter near the wall of the gland. Between the separate follicles we find a connective tissue with the characters of fat-cells and traversed by renal canaliculi. The secretion of the gland is neutral or faintly acid; on being dried and heated with fibrin it gave its distinct peptine reaction, which was most marked in alkaline solutions; it appears to possess both a tryptic and a peptic ferment.

Limulus an Arachnid.*—Professor E. Ray Lankester examines part for part the apparently corresponding structures of *Limulus* (the King-crab) and a Scorpion. Commencing with the nervous system, an exact knowledge of which in the latter is still a desideratum, he points out that in *Limulus* we have (*a*) an archi-cerebrum whence five nerves only are given off; (*b*) an œsophageal collar whence nerves radiate to all the pediform gnathites, as well as to the chilaria and the genital operculum, there being a distinct nerve for each appendage; (*c*) the first half of the abdominal cord gives off no nerves, the latter five pairs. Precisely corresponding portions may be made out in *Scorpio*, where, however, the brain and the œsophageal collar are more intimately fused; Newport's figure shows that the nerves "have a lateral position embracing the true archi-cerebrum." What Professor Lankester calls the *attraction* of nerve-organs to the œsophageal collar has gone further in *Scorpio* than in *Limulus*, for the nerves for the segments containing the first two pairs of lung-books likewise arise from the collar itself.

The striking resemblances between the skeletons of the two forms are next illustrated, and it is pointed out that the so-called compound eyes of *Limulus* are more correctly regarded as aggregations of simple eyes; the differences between the abdominal regions are diminished when we remember that the embryonic *Limulus* has a series of separate segments in this region, the presence of which is still denoted by a series of ridges and by the lateral spines, each of which would appear to possess its separate musculature, as well as by the dorsal pits or "entapophyses." Between this and the anus, *Limulus* has an area which is only potentially segmental, and behind these comes in both a telsonic spine. Behind the six cephalothoracic appendages there is the genital operculum, a lid-like plate which in *Limulus* retains throughout life indications of its double origin, but in *Scorpio* is only bifid at its free margin. As is well known, the 8th pair of the appendages in the Scorpion are the *pectines;* in the King-crab, the pieces on either side become united across the middle line, but on their under surface there is still to be seen "a series of very delicate lamellæ, corresponding to the lamelliform teeth of the Scorpion's comb-like appendages. Precisely similar pieces are found on the 9th–12th appendages of *Limulus*, but in the Scorpion the rudimentary appendages have disappeared," but only from view—in other words, the lamelligerous appendages of these four segments sink within the lung-invaginations. When a close examination of the sternal area of this region of *Limulus* is made stigmata are found which lead into

* Quart. Journ. Micr. Sci., xxi. (1881) pp. 504–48 (2 pls.).

pits; these parabranchial stigmata are found on the posterior face of the median sternal lobe which unites the two halves of the lamelligerous appendage; they are connected with powerful muscles, the function of which is clearly to agitate the plate-like organ, for the purposes of respiration. A still more intimate knowledge of the structure of the lamelligerous appendages in the two forms reveals their essential similarity in structure; an axis springing from the body-wall has its posterior face provided with a transverse series of lamellæ; when these are all set in a corresponding position we find that they are always imbricated, and that the imbrication is identical in all, and that they only present such differences, as density of structure, &c., as are to be explained by a reference to their different positions and functions. The history of these structures is next hypothetically detailed, and it is pointed out that in living Scorpions the original stigma has closed up and that a new opening (the stigmatic slit) has been developed within the area formed by the closure of the stigma; and air now enters where before there was blood.

The characters of the free entosternite in the two forms are then described and compared; and it is stated that in no Crustacean are such developments to be observed. The alimentary tract is similarly treated, and the fact that the proctodœum is so short in *Limulus* is stated to be one of the most important points of difference; but this itself is only a part "of that general reduction of its hinder segments"; another difference is the absence of Malpighian glands in the King-crab. This portion of the paper concludes with an account of the circulatory and generative organs.

The *Eurypterina* present numerous well-marked indications of forming a link between the two forms here compared together. After a review of the opinions held by preceding writers, Professor Lankester proceeds to the development in time of *Limulus* and the Tracheate Arthropoda; from the latter he would separate the Arachnida as not having any special connection with the Hexapoda and Myriapoda, the exact relations of which to the other Arthropods is still a matter for speculation. The Arachnida may be divided into three orders: Hæmatobranchia (= Merostomata), Aerobranchia (Scorpions and Spiders), and Lipobranchia (Mites, Pseudoscorpions, &c.).

Function of the Caudal Spine of Limulus.*—J. de Bellesme, after pointing out that this organ cannot, on account of the mode of disposition of the spinules on its lower surface, act as an organ of offence, the need of which, for such a creature, can hardly be imagined, states that the appendage may move vertically through 80°, and that it has a great power of lateral movement. When a King-crab falls on its back, it flexes its prothorax and the tip of the spine touches the ground; the creature now rests on only two points; easily enough it sways to one side or the other till one edge of the carapace touches the ground; all that it then has to do is to alter its centre of gravity by moving its limbs, and it will be found to veritably fall on its feet.

* Ann. Sci. Nat. (Zool.), xi. (1881) art. No. 7, 5 pp.

δ. Crustacea.

Adaptations of Limbs in Atyoida Potimirim.*—This Brazilian fresh-water shrimp to which Dr. Fritz Müller has already † drawn attention in connection with its coloration, is now described on account of the peculiar structure of its first thoracic leg and some other of its appendages. Instead of being constructed, as in the immediate allies of *Atyoida*, ‡ to cleanse the branchial cavity, the appendage mentioned acts as a kind of spoon to provide the mouth with supplies of the fine mud on which this species lives. Whereas in the nearly allied genus *Palæmon*, the "hand" (propodite) is long, and provided with a grasping apparatus in the form of a long slender thumb and movable finger (dactylopodite), in *Atyoida*, the proximal portion of the hand is almost aborted, the finger being articulated to the thumb itself almost in the joint between the hand and carpopodite. The end of each of these parts is provided with a tuft of long bristles, which, when the hand is open, form a kind of fan which detains the fine mud; when the hand is closed the bristles are closed around the mud, compressing it into a pellet, which is passed into the mouth with great rapidity; the same takes place with the three following maxillipedes. Further, the posterior maxillæ, the first and the middle maxillipedes, have each an unusually long and straight inner edge, fringed with bristles of peculiar form, and, in conjunction, forming an organ admirably adapted for receiving the pellets of mud brought in by the legs. The mandibles form a remarkable exception to the rule in the order, in being unsymmetrically developed, a condition which appears to be rather due to preservation of an ancestral character than acquired by adaptation, as the jaws in their earlier stages resemble those of the *Cumacea* and *Amphipoda*.

The 3rd, 4th, and 5th maxillipedes bear the usual appliances for grasping water-plants; but the lower edge of the dactylopodite of the 5th pair is provided with a comb-like appendage for cleansing the abdomen; for this purpose the abdominal appendages are successively bent forward and subjected to its operation, and finally the tail itself. The branchial chamber is cleaned by the 2nd pair of maxillæ, the outer part of which is usually known as the scaphognathite; its epipodite portion, instead of being short and broad, is long and narrow, tapers to a point, and carries a dozen long flexible bristles, and is thus able to reach as far into the chamber as the gill of the 3rd ambulatory leg, and to reach with its bristles to the very extremity of the chamber, and thus to traverse all the surface of the branchiæ.

Another contrivance serving the same purpose, is the set of small sausage-shaped processes which spring from near the anterior edges of the coxopodites of the posterior maxillipedes, and the three anterior ambulatory legs; each process carries about a dozen long hairs and lies back over the coxopodites, and being placed in the entrance to the gill-chamber, hinders, in conjunction with its fellows, the admission of foreign objects. The want of a similar provision in

* Kosmos, viii. (1881) pp. 117-24 (20 woodcuts).
† Cf. this Journal, i. (1881) p. 452.
‡ See this Journal, iii. (1880) p. 63.

the case of the 4th and 5th pairs of legs, is supplied by the remarkable forward projection of the exopodite of the 1st pair of abdominal legs, which plays in front of the space between the last ambulatory leg and the carapace.

As in the case of other shrimps in which the male is not provided with offensive weapons, that sex is smaller than the female; its chelæ are adapted only for prehension of mud; the only appliances by which the female is grasped in copulation are a bent claw on the last maxillipede, and a strong toothed hook on the inner aspect of the tarsi of the 3rd and 4th legs. The *spina pterygostomiana* of the lower edge of the front of the carapace, which has been used as a generic character in *Leander*, is here present only in the adult female; it is thus here merely a sexual distinction; the young females agree, however, with the males in this, and also, owing apparently to their similar proportions, in the number of bristles on the telson.

These numerous peculiarities in the structure of *Atyoida* distinguish it from its allies, *Palæmon*, *Hippolyte*, &c., in the same way as not one but several peculiarities usually separate other species and genera, and also families from each other. The connection between the peculiarities in this case lies in the peculiar mode of life, viz. the use of mud as food-material, and the habit of clinging to plants; which has caused the modification in such an extraordinary manner of the parts concerned in, or affected by these functions.

Colour-sense in Crustacea.*—C. Mereschkowsky has experimented with the view of determining whether the lower Crustaceans distinguish colours.

Larvæ of the Cirrhipede *Balanus* and some marine Copepoda, enclosed in a vessel, seemed fully alive to the difference between light of any kind and darkness; for whereas, in the dark, they were scattered throughout the vessel, they always gathered about a ray of any light coming from a slit. The author considers, however, that it is exclusively the *quantity* of light, not the *quality*, that affects them. Using two slits, one to admit white light, the other coloured, he found that they preferred the former—*all* gathering round it if the coloured light was deep red or violet, and *most* of them if the colour was bright red, yellow, or green. They always preferred a bright light like yellow to a sombre one like violet. When two rays of equal intensity were admitted they gathered in nearly equal numbers about them, whatever the nature of the colours. There is, then, a great difference in the mode of perception of light, between the lower Crustaceans and man, and even between them and ants. While we see different colours and their different intensities, the Crustaceans see only one colour with different variations of intensity. We perceive colours as colours; they only perceive them as light.

Germs of Artemia salina.†—A. Certes has a note on the vitality of the germs of this species and *Blepharisma lateritia*. He states that having evaporated some water and collected carefully the sediment, he three years afterwards heated the residue with boiled

* Comptes Rendus, xciii. (1881) pp. 1160–1. † Ibid., pp. 750–2.

and filtered rain-water. On the following day, and notwithstanding that all care had been taken to keep out germs from the air, Flagellata exhibited themselves; soon afterwards there came Ciliata; about two months later Nauplius-like germs were detected, the number of which rapidly increased, and later on they took on the form of *Artemia salina*. The author points out that, in cases of this kind, death has only been apparent; organic combustion and nutritive changes have not ceased entirely.

A somewhat similar account is given of the rare rose-coloured Infusorian *Blepharisma*.

Vermes.

Origin of the Central Nervous System of the Annelida.*—Prof. N. Kleinenberg gives a summary of the results obtained by him in studying the development of the Polychæta, upon which he proposes hereafter to publish a more extended memoir with figures. At present he confines himself to making known the development of a single species, the larva of *Lopadorhynchus*, until its transformation into the perfect animal.

The most interesting point in the present communication is the discovery of the circular nerve of the vibratile organ of the larva, and the investigation of the development of the central nervous system of the perfect animal. The author has found that during the transformation of the larva into the perfect animal the circular nerve disappears completely, together with the vibratile organ; and the rudiments of the typical central organs are not derived from the transformation of the circular nerve, but originate from other parts of the ectoderm. Consequently the nervous system of an Annelid is not homologous with that of its larva. He thinks that the larvæ of the Annelida possess only the central anterior nervous system of the Cœlenterata, but that the perfect animals have central organs proper to them; so that "the organ of the inferior type originates and functions in the larva, but is eliminated and replaced by new formations in the adult animal."

Swim-bladder-like Organs in Annelids.†—Dr. H. Eisig states that in preserving specimens of *Hesione sicula*, he has often observed a considerable number of air-bubbles escaping from the mouth or anus; by this and by the observation that in some cases specimens of the same Annelid are found passively floating on the surface of the water in which they were placed, he was led to the discovery that two contractile appendages communicate with the intestine, and that these must be regarded as the reservoirs of the gases; according to their condition they may appear as inconsiderable diverticula or as distinct bladders; he explains the fact of their being overlooked by previous observers as due to their ordinarily empty condition after death. On examining specimens of *Syllis aurantiaca* it was found that the so-called T-shaped glands of the Syllidea are swim-bladders.

* Atti R. Accad. Lincei, Transunti, vi. (1881) p. 15. See Ann. and Mag Nat. Hist., ix. (1882) p. 67.

† MT. Zool. Stat. Neapel, ii. (1881) pp. 255-304 (3 pls.)

When a detailed examination is made of *H. sicula* it is found that the enteric tract may be divided into (*a*) a proboscis with an œsophagus, (*b*) the proper digestive gut, and (*c*) an intermediate fore-stomach to which the bladders are attached. The first and last portions of the gut (*a* and *b*) differ not only in external appearance, but also in structure; while in the former the epithelium is feebly developed, in the latter it gives rise to a well-developed mucous membrane; the constituent cells are greatly elongated and are ciliated at their free extremity; it is also richly supplied with blood-vessels which, as in the clitellum of the Earth-worm and the epithelium of the Leech (Lankester), interpenetrate between the cells; this rare and remarkable arrangement would appear to be explained by the fact that in the *Hesione* (as in *Syllis*) the gills are absent.

The fore-stomach has very thin walls and when contracted is hardly of the length of a somite; it is, however, capable of great extension; in its structure it is intermediate between the œsophagus and the gut proper; for, while it resembles the former in the characters of its epithelium, it has the musculature of the latter. At its side the two bladders open. Till they approach their orifice these bodies have a ventral position, they appear to be easily contractile and of great extensibility. When full they form saccular reservoirs; when empty cylindrical tubes, which gradually diminish in diameter towards their blind end. Their orifices are wide, but there is a means by which food is prevented from entering them, and the valvular arrangement is such that, the mouth or anus being closed, gas or water enters them where the gut contracts, and water or gas passes from them into the gut when they contract. In general structure they resemble the fore-stomach, of which therefore they may be regarded as diverticula.

On examining the characters of the blood-vascular system we see a dorsal double trunk, a ventral single, and two lateral ones; the two former, by numerous anastomoses, carry venous blood to the walls of the stomach, whence it passes to the lateral trunks; these are of considerable size and contract rhythmically and supply the greater part of the body by the thirteen arteries which are given off from them to as many somites. The ventral and the lateral vessels are also in direct connection by several anastomoses, and each artery is likewise in communication with the ventral enteric vessel. In other words, the greater quantity of blood is brought into connection with the intestine.

Other Hesionids and the Syllidea are then described; after which the author passes to a consideration of the function of the swim-bladders; these were never found to contain food or to give rise to any secretion; they contained nothing but a varying amount of clear fluid and gases, both of which could be driven into the stomach, or *vice versâ*. The fluid is sea-water, taken in from without, and this water appears to be taken in for respiratory purposes. As to the "air," experiment first of all showed Dr. Eisig that it was not atmospheric air, and the question whether it was secreted in the animal itself was examined, after the following considerations; the air-bladders are thin-walled, elastic, and without blood-vessels; the gut has thick glandular walls and is richly supplied with blood; it is, then, the prime seat of the respiratory processes. As it was impossible to examine the small quantity of gas, the question of its real character could not be decided by chemical analysis, but the author concludes that it is oxygen secreted from the mucous membrane of the stomach; and as the bladders cannot be supposed to have any hydrostatic function, he thinks that they are truly reservoirs of oxygen, which can be called upon at periods of digestion and so on, when the animal is unable to take in a quantity of fresh sea-water to aerate the blood which is passing in such quantities through the walls of its stomach.

As to the morphological significance of these appendages which have already been shown to be diverticula of the fore-stomach, we find them to be, in all probability, a product of the endoderm. The variations in its development which are to be seen among the Syllidea, with the general characters of *Syllis*, and the absence of any special enteric vascular system in *Tyrrhena*, lead to the conclusion that the atrophy of the bladders in some of the Syllidea is due to the development of the dermal mode of respiration. In all Annelids in which gills are wanting, and these gills are no peculiar developments, an enteric mode of respiration would appear to obtain. We may, in conclusion, suppose that, in the ancestors of the Fishes of the present day enteric respiration existed (as it does to this day in *Cobitis*); in some this mode led to the formation of a reservoir, which under hydrostatic influences took on the function of a hydrostatic organ. At the present day we see that a fish uses up all the air in its air-bladder before it is suffocated, and even that a pulmonate Vertebrate uses its lungs, in water, as a hydrostatic organ.

Development of Polygordius and Saccocirrus.*—W. Repiachoff finds that in both these lowly Chætopods the cleavage of the ova is total; that after eight segments have become developed the embryonal cells begin to develope one after another; the gastrula is formed by invagination; while the mesoblast of *Polygordius* appears to be developed from the hypoblast, in *Saccocirrus* "primitive mesodermal cells" are to be found within the cleavage cavity. Even during the blastula-stage the embryos of *Polygordius* begin to swim about by means of very fine cilia; after the closure of the blastopore the larva becomes more vermiform; the now-closed anterior end remains, however, for some time distinctly swollen out. Movable hairs appear at scattered points on the surface of the larva, which give to the creature something of the appearance of a larva of *Sagitta;* later on, two cirri become developed at the anterior end, but this species of *Polygordius* (*P. flavocapitatus*) never passes through the stage of the Lovenian larva.

Termination of Nerves in the Voluntary Muscles of the Leech.†—A. Hansen states that the nerves divide and subdivide without forming anastomoses, and lose themselves in the muscles without our being able to discover their terminations; in only one

* Zool. Anzeig., iv. (1881) pp. 518–20.
† Arch. de Biol., ii. (1881) pp. 342–4.

case was such a termination even unsatisfactorily observed. From a common trunk composed of several fibres one separated and ended at a muscle; here it divided into two fibrils, which each terminated in a muscular fibre, where it formed a kind of motor plate; the arrangement, therefore, was very similar to that described by Ranvier for the muscles of the stomach, from which it differs only in the somewhat larger size of the plate.

The Echiurida.*—Professor R. Greef is of opinion that there is no close genetic affinity between the Gephyrea and the Echinodermata, but that the former represents a distinct class allied to the Annelids and divisible into an armed (Echiuridæ) and unarmed (Sipunculidæ) group.

In this elaborate monograph he deals, after an historical and a bibliographical introduction, with (1) their distribution, which appears to be very wide, though *Bonellia* is confined to the Mediterranean area, and *Echiurus* to the northern side of the equator. Their coloration can only be made out in the fresh condition as the pigment is soluble in alcohol. The various organs are dealt with in order; the presence of a central canal in the nervous system is noted, and it is suggested that it is a remnant of the ectodermal invagination; fluid is to be found in this canal. A full account is given of the curiously minute male of *Bonellia.* The essay concludes with a systematic definition of the family, and of the three genera and fifteen species of which it is composed.

Segmental Organs and Genital Gland of some Sipunculida.†—Dr. C. P. Sluiter discusses the question whether the so-called brown tubes have or have not an opening into the cœlom; after having had the opportunity of examining a number of fresh tropical forms, he has almost always been able to detect an orifice, which, however, was not, as is ordinarily stated, placed near the anterior, but just beside the posterior end of the tube; in only one case was the orifice anterior and then there was an infundibular structure developed which communicated by the funnel with the interior of the tube; the funnel proper consists of four lobes, two larger lateral, and a small dorsal and a small ventral; about the middle of the funnel the lobes fuse with one another to form the tube. In some few cases the author was unable to observe either an anterior or a posterior orifice; this was in forms in which the longitudinal musculature was not differentiated; the wall of these brown tubes is, however, extremely thin, and can be easily ruptured. In structure the walls generally exhibit a circular and a longitudinal layer of muscles, and a series of radial glandular tubes. The author describes the generative organs, and finds that the glands form sausage-shaped structures in a deep groove between the dorsal retractors; these bodies have a wall of fibres of connective tissue which extends and is attached to the wall of the exterior; the inner side of this wall is invested by a layer of small mother-cells from which egg-cells are regularly given off. In other forms the

* Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 1–172 (9 pls.).

† Zool. Anzeig., iv. (1881) pp. 523–7.

generative glands formed ridges of connective-tissue fibres which did not form rounded bodies, but widely open grooves which extended between the muscles; on the inner face there is again a layer of mother-cells, which give rise to egg-cells. The male organs were only once observed, when they were seen to present all the essential characters of the female.

Anatomy and Histology of Sipunculus nudus.*—Dr. J. Andreæ here gives a full account of his investigations, the preliminary notice of which we have already noted.† With regard to its external form, he points out that, owing to its rich supply of muscles, the integument is highly contractile and that consequently the creature can, and does, take on the most various forms. The cuticle is thin, transparent, and so arranged as to be iridescent during life; the pores of the glands are irregularly distributed over the whole of the body, and vary in size according to the size of their glands. The pigment-spheres have been but rarely noticed, although they are widely distributed over the body; varying much in dimension, they are seen in sections to be provided with a doubly contoured covering, within which there is a brown granular mass, containing a number of elongated oval nuclei. The circular musculature of the body does not consist of a continuous layer, but of a number of flattened broad bands, the space between which altogether disappears when the animal contracts in diameter. In addition to these and the longitudinal muscles there is a much more delicate layer of diagonal fibres, more widely separated from one another. The walls of the tentacles are a direct continuation of the proboscis, and within there is a cavity connected with the circumpharyngeal vessel. The value of the integumentary cavities as the seats of respiratory activity is insisted upon, as is the fact that the ventral cord, unlike that of Annelids, is single and not double; the cord, further, presents no ganglionic swellings except at its termination, though, owing to its form, there would, on superficial examination, appear to be such. The supra-œsophageal ganglionic mass is biscuit-shaped, and presents distinct indications of having been originally double; like the ventral cord, it is traversed by a network of connective-tissue fibres, and the ganglia are most largely present on the ventral surface of the two spheres, on the anterior margin of the projection, and at the tip of the finger-shaped processes which are given off from it.

The author is of opinion that the group of the Gephyrea is a natural one, that it stands closest to the Annulata, and that it is justifiably divisible into the two orders of the Sipunculida and Echiurida.

Sternaspis.‡—In this elaborate monograph the structure and development of this Gephyrean is very fully treated by Dr. F. Vejdovsky. He distinguishes a fore- and a hind-body, and recognizes seven segments in the former and a varying number in the

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 201–58 (2 pls.).
† See this Journal, i. (1881) p. 892.
‡ Wien. Denkschr., xliii. (1881) pp. 33–90 (10 pls.).

latter, from eight to twenty-two being there developed; but in their case the intersegmental grooves are not found at the sides of the body; they are all provided with a single lateral row of setæ. The hindermost part of the body is characterized by the presence of a ventral shield which on the ventral surface takes the place of a number of segments. The gill-filaments are spirally coiled and form two dorsal pre-anal tufts. On examining the dermo-muscular tube it is found that the hypodermis in the median segments forms a homogeneous layer, here and there traversed by fine fibres of connective tissue, but altogether devoid of the unicellular glands which are so frequently found in this layer in Chætopods and other Gephyreans; the structure of the hypodermis in other regions is also described. The cuticle is much thicker at the posterior than at the anterior end of the body and is thicker than in any other Gephyrean or Chætopod known to the author. The cross-bands found on it seem to prove that in life the cuticle must be intensely iridescent. The surface of the cuticle is covered with special dermal cirri, which are continuous with the subjacent layer by dermal pores; these cirri are filamentous and vary in form in different parts of the body; capillaries have been observed in some of them, and there seems to be no doubt but that they have a respiratory function.

Sternaspis is distinguished from all other Gephyrea and Polychæta by the peculiar disposition of its setæ, which fall into three different groups, the arrangement, muscular supply, and development of which are fully described.

The cerebral ganglia occupy the whole of the cephalic lobes; the ganglion-cells occupy the upper, lateral, and basal parts, while the fibrous substance lies between them; there is still a close connection with the ectoderm. The greater part of the brain consists of cellular elements, which exhibit distinct bilateral symmetry; the cells vary greatly in form and size. The two bands of the œsophageal ring are proportionately long, and consist of fine nerve-fibres, without any ganglion-cells. The ventral cord is regularly rounded, and at first lies freely in the cœlom; it then runs between two bands of longitudinal muscles, without giving rise to any ganglionic swellings till the end of the body is reached; the complicated arrangement of the cells and fibres in the cord was made out by the aid of sections. Comparing this system with that of allied forms the author finds it to be intermediate between what is found in Gephyrea and Chætopods. On the other hand, in the character of the enteric canal *Sternaspis* stands nearer the Gephyrea than the Chætopods.

The vascular system is very complicated; in addition to the two primary vessels, or hearts, there are a number of lateral vessels, which form remarkably close plexuses in all the organs, and there is also a special branchial system. There appear to be a pair of lateral vessels for each segment of the body. The segmental organs form a pair of brown bodies lying on either side of the œsophagus in the fifth and sixth segments; they are of a spongy texture and may be seen to contain a quantity of refractive concretions, which prove their renal function; they have no external orifices. The sexes can only be distinguished from one another by the reddish colour of the ovaries, and the whiteness of the testes. They lie in the coils of the enteric canal, and are in both cases provided with a pair of ducts, which open to the exterior between the seventh and eighth segments. No directive corpuscles could be observed in the mature unfertilized ova. The ducts of *Sternaspis* appear to be special structures and not modified segmental organs. The cleavage of the egg appears to take place rapidly, inasmuch as after sixteen hours there are seen ciliated embryos; the whole of the body, with the exception of the hinder end, is covered with very fine cilia, and a tuft of longer ones is seen at the anterior end. The embryo gradually grows narrower posteriorly, and the porous cuticle corresponds exactly to the yolk-membrane, which seems to grow with the body. The anterior end becomes divided into three lobes, of which the median is the largest. At this period the endoderm fills up the whole of the tube formed by the ectoderm, and, so, exactly resembles the *Planula* of the *Hydromedusæ.* After forty-eight hours the larvæ are twice as large, have lost all their cilia, and have the form of a non-ciliated Turbellarian without mouth or anus. A new cuticle, which has very much the appearance of a former one, is developed over the whole of the body; the ectodermal cells become much more distinct, and those of the endoderm begin to indicate the formation of the enteric tube. At the hinder end of the body the two layers are now separated and the intermediate space is occupied with spindle-shaped nucleated elements, which perhaps owe their origin to the endoderm. After five days the cephalic lobes appear, and the mesoderm is found to have given rise to muscle-cells. On the sixth day, when the observations ceased, the excretory canals began to appear.

In conclusion, the author thinks that there are four natural orders of the class Annelides: (1) *Hirudinea*; (2) *Oligochæta*; (3) *Polychæta*; and (4) *Gephyrea.* In a phylogenetic table he shows that he would derive the first two from the *Discodrilida*, and the other two from *Sternaspis*; the Discodrilida form an offshoot from the Oligochæte stem which descends into the Amedullata, which, with *Sternaspis*, have their common origin in the Turbellaria, which, for their part, are derived from the Cœlenterata. The Polygordiidæ (*Achæta* Balfour) seem to Dr. Vejdovsky to form a group of the Polychæta.

The author believes that the larvæ of the Chætopods and Gephyrea are formed on the same type, and that in *Echiurus* there is a true segmentation of the body.

Hamingia glacialis.*— In his detailed account of this new Echiurid,† Dr. R. Horst points out that the digestive tract presents a number of coils, that the mouth forms an elongated cleft, and that the conical pharynx is separated by a constriction from the œsophagus; this latter is somewhat pushed to the right side owing to the great development of the uterus. The vascular system possesses a ventral vessel which accompanies the ventral end, along its whole length; a dorsal vessel which does not extend over more than half of the body,

* Niederl. Arch. f. Zool., Suppl. Bd. i. (1881) 1st art., 12 pp. (1 pl.).
† See this Journal, i. (1881) p. 891.

and a neuro-intestinal anastomosis, by means of which the two primary trunks communicate with one another. The ovarian tubes agree generally with those of the other Echiuri, and the tubes, being in the specimen examined filled with ova, had a yellowish colour. Just as in *Echiurus*, the proper covering for the egg which is found in *Bonellia*, is completely absent. The author is unable to make any statement as to the male organs.

Echinorhynchus.* — P. Mégnin states that the menisci of this parasite open at the base of the proboscis by a large buccal pore; in *E. brevicollis* the menisci are replaced by two long cylindrical tubes which open into a groove at the base of the proboscis, and extend as far as the hinder extremity of the body; they are clothed internally by polygonal cells, and the whole arrangement strongly calls to mind the bifurcated intestine of some Distoma. This intestine, which is to be seen in encysted larvæ and, undergoing atrophy, is only represented by the menisci in the adults of most species, persists in certain forms. The author thinks that this arrangement indicates some affinity of the Acanthocephali with the Trematoda, and separates them from the Nematodes, with which order they are frequently placed.

Proscolex of Bilharzia hæmatobia.† — J. Chatin states that the ovum is regularly oval, and has a kind of apical tubercle at one pole, a character which is extremely rare among the Trematoda digenea, though common enough among the T. monogenea. The infusoriform character of the larva is pointed out, and the anterior end is stated to become shortly differentiated into a cæcum which projects into the body-cavity, and which the author, agreeing with Dr. T. S. Cobbold, looks upon as being the first rudiment of the digestive tract. This being, then, possessed by the larval form, it should rather be spoken of as scolex (Rédia) than as proscolex; and this view would be strengthened by the certainty of the sarcode spherules being, as the author thinks they are, young gemmæ in course of development. These amœbiform bodies are shown not to have the special outer layer of the simpler organisms (Amœbæ), but rather a cuticle distinctly differentiated, and not unlike the protecting layer which we find on the young Cercariæ developing within a sporocyst or a Rédia.

Nervous System of Cestoda.‡ — In the third part of his account of his investigations into this system of the Platyhelminthes, Dr. A. Lang deals especially with the Tetrarhynchi, which he chose on account of the notorious difficulties which are associated with the investigation of the Tæniadæ, and because of the promise of a well-developed nervous system given by the large amount of muscular tissue in the scolex, and of the large size of some of the species. Difficulties, however, were not evaded; nothing of value can be obtained by maceration, and nothing at all by examination of living specimens. Transverse sections carefully made gave good results.

* Comptes Rendus, xciii. (1881) pp. 1034–6.
† Ann. Sci. Nat. (Zool.), xi. (1881) art. No. 5, 11 pp. (1 pl.).
‡ MT. Zool. Stat. Neapel, ii. (1881) pp. 372–400 (2 pls.).

The following forms were examined :—(1) *Rhynchobothrium corollatum*, from the intestine of *Mustelus levis;* (2) Scolices of *Tetrarhynchus*, from the muscles of *Orthagoriscus mola* (probably *T. gracilis*); (3) *Anthocephalus elongatus*, from the liver of the same fish; and (4) *Anthocephalus reptans*, from *Symnus lichia*.

The scolex may be divided into three parts: (*a*) a cephalic region, which carries the sucker; (*b*) a cervical region, containing the sheaths of the proboscis; and (*c*) a bulbous region, which carries the swellings of the proboscis. In the first of these we find in the more anterior sections four outer cephalic and four inner cephalic nerves; in the succeeding sections these eight nerves are thicker and more distinct, two are now approaching the region of the cerebrum; in the next section we find on either side a commissure between the upper and lower internal cephalic nerves; then one between the upper and lower outer nerves; within these commissures there are small bipolar ganglionic cells with a large nucleus and a distinct nucleolus. The inner cephalic nerves give off smaller ramules.

Further back, not only are the four upper connected by commissures with the four lower nerves, but the two inner, on either side, are connected by a transverse band with the two outer. From the outer angles of the squarish mass thus formed a strong nerve is given off which passes to the sucker. As yet, the two halves of the cerebrum appear to be independent; but, further back, there are two connecting commissures. Still further back sections are found to exhibit a united transverse commissure, which gives rise to a band-shaped cerebral mass, enlarged towards its middle and at either end.

The author then compares this account of what obtains in *T. gracilis* with the arrangements which are found in the other forms that he examined.

Passing to the cervical portion of the scolex, we find the two longitudinal trunks which arise from the brain; they lie, on either side, within the dermo-muscular tube, between the ascending and descending water-vessel. Here and there they give off delicate nerves which, generally, pass off to the dermo-muscular tube. The author directs attention to the presence of a somewhat disturbing element on the inner side of the nerves; these appear in section as dotted masses; they turn out to be the united efferent ducts of the large number of gland-cells which are imbedded in the parenchyma of this region of the body.

In the bulbous portion the longitudinal nerves present much the same arrangement as in the cervical part, and the chief interest centres in the branches which are given off from them; the separate fibres of these enlarge here and there into very long and large ganglion-cells. In the proglottides the lateral nerves extend to the end of the chain, retaining their former relative position; they are best developed in the more anterior joints, in which the generative organs are still feebly developed. Towards the hinder end they become more indistinct.

After some critical remarks on the observations of earlier observers, the author passes to *Amphilina*, an unjointed Cestode; the spongy cords which Salensky, following Sommer and Landois, regarded as water-vessels, are regarded as true nerves; in longitudinal sections their course can be easily followed; the longitudinal nerves extend through the whole of the body and unite at the posterior end. They give off outwards at short distances small ramules, which probably innervate the dermal musculature, and they also occasionally give off internal branches. Some little way behind the anterior end of the body the nerves give rise to a small thickening, which becomes united by a commissure with its fellow of the opposite side. From the thickened ends of this cerebral commissure a well-developed nerve passes forwards, to supply the most anterior end of the body and the muscular walls of the sucker. There is, on the whole, a not inconsiderable resemblance to what obtains in the Trematoda.

In conclusion, Dr. Lang sums up the state of our knowledge as to the nervous system of the other Cestoda: *T. perfoliata* has a better developed nervous system than the rest of the Tæniadæ; the anastomosis or cerebrum contains nuclei and fibrils, gives off two lateral primary trunks, and completely resembles in structure the same parts in the Nemertinea; *T. solium*, with others, has three cords on either side. In the Bothriocephalida the water-vessels are on the outer side of the longitudinal nerves, and here also the anastomosis is concave anteriorly; in the Ligulida the connecting commissure forms a pretty broad bridge, the lateral trunks lie outside the water-vessels, and are approximated towards one another in the anterior region of the body.

Development of the Ovum of Melicerta.*—L. Joliet points out that the development of the embryo of Rotatoria has as yet been studied in only two genera—*Brachionus* by Salensky, and *Pedalion* by Barrois. The mode of segmentation is still unknown.

Although the author has ascertained † that the development of the winter-egg and of the male egg agrees in a general manner with that of the female summer-egg, it is more especially on this last that his researches have been made.

Within the maturation-sac it presents, in the middle of the germinal vesicle, a small but very distinct germinal spot. After deposition this spot speedily disappears. It did not appear to the author that there was any emission of a polar globule. The first segmentation-plane perpendicular to the major axis of the egg, which is an irregular ovoid, divides it into two very unequal segments. Afterwards the two segments divide symmetrically, and so that each furnishes eight of the spheres which constitute the egg in the stage xvi. The spheres derived from the larger primary segment are larger than the others, and also larger in proportion as they are further from the animal pole. Each would appear to have, so to speak, a certain degree of animality. Throughout the whole duration of the segmentation, the part played by the nuclei and the asters is very remarkable. A rotatory movement, already noted by Barrois in *Pedalion*, is

* Comptes Rendus, xciii. (1881) pp. 856–8.
† See this Journal, i. (1881) p. 894.

also observable, which tends to transport the spheres derived from the small segment from the animal pole to the opposite one, skirting the dorsal face, while the large spheres give place to them and glide along the ventral face.

At the stage xvi. the egg is composed of a row of four small cells derived from the small segment and occupying the dorsal face, of four spheres, larger and larger, occupying the ventral face, and of two rows of four cells placed on the sides, and four derived from the large and four from the small segment.

It is only after this stage xvi. is reached that the dorsal and lateral cells commence to multiply much more rapidly than the ventral ones, and to spread over their sides. In proportion as these small cells glide over the surface of the large ones, the latter sink with an oscillatory movement, which at first removes the smaller ones, until at length the last and largest glides in its turn under the first, leaving an orifice, the blastopore, which remains visible for some time almost exactly at the spot where, later on, the mouth is formed.

By the very place which it occupies from the moment of the closing of the blastopore, it is easy to see that the last sphere enveloped corresponds to the intestine, which it will serve to form, if not entirely, at least in great part.

In the same way, by the manner of their inclusion, the two large spheres following will be on the ventral face of the first, in the situation which the genital organs will occupy. Later on, when the spheres begin to divide and subdivide, this disposition becomes very obscure; but for a certain time after the closing of the blastopore it remains perceptible, and shows that the embryo is formed, if not of continuous layers, at least of masses of tissue which obviously correspond to the endoderm, mesoderm, and ectoderm of the higher animals both in their position and destination.

When the subdivision has been pushed to its furthest limit the egg presents the form of a finely moruloid mass, in which can only be recognized an outer light layer and a darker central one. The cephalic region always remains lighter. The blastopore is no longer distinguishable.

Soon, along the side and ventral face an oblique furrow appears which constricts the mass and separates the tail; the latter is thus folded under the ventral surface and directed towards the head, as in the embryo of *Brachionus* and *Pedalion*.

About the level of the caudal extremity a depression appears in the cephalic mass; it is uncertain if it corresponds to that described by Salensky in *Brachionus*, but it indicates the appearance not of the mouth but of the vibratile pit situated under the lip in the adult. A little later, and somewhat higher up, the mouth appears, as a depression sufficiently sunk, without doubt to form the mouth, but certainly not sufficiently to form the mentum. Yet later, and also on the back, the cloaca is formed by an invagination of the ectoderm, and this, though very long in the adult, is as yet very short in the larva, and remains reduced to a simple emargination in the Floscularæ. The cephalic region is soon defined by a slight fold, which indicates the margin of the chitinous covering. The eyes appear as two red points; cilia commence to move, at first on the infra-buccal pit, then on the mouth, and finally on the top of the head, where they form a circlet. The armature of the mastax comes into existence, the tail retires little by little towards the extremity of the egg, whose envelope it finally ruptures. The larva has been already described by several authors, and M. Joliet only insists on the fact that, like the larva of *Lacinularia* figured by Huxley, it presents cilia on three parts of its body; a continuous, and at this time scarcely sinuous circlet placed above the mouth; a second circlet surrounding this and the mouth, stretching even over the vibratile pit; lastly, a tuft of cilia at the extremity of the tail. The larva remains active for some hours, and then becomes fixed by means of the glands enclosed in its tail. It then commences to collect in its vibratile pit the minute particles held in suspension in the water, mixes them with the secretion from the gland, hitherto taken for a ganglion, and, according to the judicious observations of Gosse and Williamson, therewith forms the pellets which, when juxtaposed, constitute the tube it inhabits.

Echinodermata.

Development of the Skeleton of the Ophiurida.* —The first point to which Prof. H. Ludwig addresses himself is the development of the arm-ossicles; these he has previously stated to be originally double, but he has never till now been able to demonstrate this by a reference to embryological data, though the discovery by Lyman of deep-sea forms in which these ossicles were distinctly double has afforded considerable support to Dr. Ludwig's doctrine. The form best adapted for investigation is the viviparous *Amphiura squamata*.

As is well known, the arms of the Ophiurid grow at the tip; the first rudiment of the ossicle consists of two calcareous pieces symmetrically placed on either side of the middle line of the arm, and each has somewhat of a triangular form; one ray is directed aborally in the long axis of the arm, the other two look adorally, and form between them a smaller angle than each of them forms with the aboral piece; these two do not, however, lie in the same plane, but one is dorsal and the other ventral, the former being further median and the other lateral in position. At an early period a distinct difference may be seen in the size of these three rays; the aboral becomes longer than the adoral rays; the form of the whole piece changes, owing to the development of calcareous processes, which sooner or later fork at their free end, and become connected with the ends of neighbouring forks, so as to give rise to the reticular tissue characteristic of the Echinodermata. In this way the two adoral pieces become connected together. Soon, too, the aboral process begins to form meshworks. This mode of growth not only takes place laterally but also mesially, so that the ends of the adjoining ossicles come into direct contact, without, however, fusing. Later on, this fusion commences both at the aboral and adoral ends: in their middle there is a space with concave sides, which only becomes completely filled up at a later stage.

* Zeitsch. f. wiss. Zool., xxxvi. (1881) pp. 181–209 (2 pls.).

The relations of the ossicles to the radial water-vessel and its lateral branches are, further, of special importance; this vessel lies, from the first, ventrally to the rudimentary ossicles, and it is only after some time that the branches to the feet become surrounded by calcareous tissue; in other words, the branches of the radial vessels have at first the relation which they retain throughout life in the Asteroidea.

After some further consideration of these points, the author passes to the terminal plate of the arm, as to which he has convinced himself of the accuracy of J. Müller's doctrine that this piece has primarily a groove on its lower surface, and that it is only later on that it becomes converted into a ring. The later observations of Prof. Ludwig have convinced him of the accuracy of his comparison of the lateral plates of the arm of an Ophiurid with the adambulacral pieces of an arm of a star-fish.

The ventral plates are reported to commence as a small tri-radiate body lying exactly in the middle line of the arm, with one aboral and two adoral rays; these, then, notwithstanding opposing statements, are unpaired pieces. The same is true of the dorsal plates.

The interesting oral pieces of the skeleton are truly the modified first ambulacral pieces; a young *Amphiura* exhibits the possession of nine skeletal pieces for each ray; one of these is terminal and unpaired, the other eight lie in four pairs symmetrically on either side of a middle line; of these two, more feebly developed, lie closer to the median plane of the radius, and more deeply in the body; the other two are better developed, and lie more superficially; the former are the first two ambulacral, the other the first two adambulacral pieces. The second pair of ambulacral pieces becomes more strongly developed than the first pair, the two pieces of which, later on, form thin calcareous plates, which descend further and further into the angles of the mouth, remain separated from one another, and, still later, give rise to the two peristomial plates. The second pair unite together and become connected with the first adambulacral pieces to form the *tori angulares*.

The first skeletal pieces to appear on the dorsal side are the five terminal plates of the arms; internally to them come the five primary radials; the central piece usually appears later on; the intermediate skeletal plates appear around the central. The so-called radial shields of the adult appear early at the outer edge of the radials. The author points out the similarities in position between the primary madreporic pore of *Amphiura* and the corresponding structure in the larva of *Antedon*.

Asterias.*—In the first part of his 'Contributions to the Systematic Arrangement of the Asteroidea,' Prof. F. Jeffrey Bell discusses the species of the genus *Asterias;* after giving a list of the 77 known species, and of the 34 well-recognized synonyms, the author proceeds to suggest an arrangement for breaking the species up into groups; He first separates the species "into those in which there are developed

* Proc. Zool. Soc. Lond., 1881, pp. 492-515 (2 pls.).

more than five rays, and those in which, so far as we know, the number five is constantly retained." For these two groups the terms *Heteractinida* and *Pentactinida* are suggested. Among the former we find that some of the species have more than one madreporic plate; the secondary divisions, therefore, are named *polyplacid* and *monoplacid*. The value and character of the number of rows of adambulacral spines is next discussed, and the terms *Monacanthida*, *Diplacanthida* and *Polyacanthida* are applied to the forms in which there is one, two, or more than two such rows. Some species are shown to have their madreporic plate encircled by spines, and these forms are distinguished as being *echinoplacid*. The next character used depends on the arrangement of the spines, "on special local modifications of the integument, which may be known as special plates"; such forms are *autacanthid;* those in which the more ordinary arrangement obtains are known as *typacanthid*. The last character used for the formation of small groups depends on the form of the spines on the abactinal surface; and here we have *simplices*, *rarispinosæ*, *obtusispinosæ*, and *acutispinosæ*.

After a table, in which this system of grouping is worked out, the author passes to the "mode of formulating results," using a certain number of symbols, and distinguishing heteractinid from pentactinid forms by placing over their formulæ the mathematical sign of the square root. Short formulæ are given for most of the known species. Thus, for the well-known *A. rubens*, we have the formula 2 *ats*, for it is diplacanthid (2), anechinoplacid (*a*), typacanthid (*t*), with simple dorsal spines (*s*). Again, $\sqrt{1\,p}$ is sufficient to distinguish *A. calamaria* as a monacanthid, polyplacid, heteractinid form. "If we know, as we do in this case, further details, we may write the formula $\sqrt{1\,paa'}$; or, in other words, in addition *A. calamaria* has no spines round its madreporic plate, and the dorsal spines are placed on special plates."

The author then makes some observations on the species of *Asterias*, found in the British seas, and concludes with the description of five new species: *A. philippii*, *A. inermis*, *A. verrilli*, *A. spirabilis*, and *A. rollestoni*, for all of which, as also for *A. japonica*, of which a description is given, the author gives the "general formula."

Spines of Asteroidea.*—At the conclusion of a description of a new species of *Archaster* (*A. magnificus*), Professor F. J. Bell points out that in littoral species, at any rate, the strength and number of the spines is in inverse proportion to the stoutness of the skeletal plates; when these are strong the star-fish is enabled to withstand the bite of an enemy; but when they are weaker, a defensive apparatus is provided in longer, stronger, and stouter spines.

Cœlenterata.

Prodrome of the Anthozoan Fauna of Naples.†—Dr. A. Andres here gives a systematic catalogue of the species, with synonymy, &c.,

* Ann. and Mag. Nat. Hist., viii. (1881) pp. 440–1.
† MT. Zool. Stat. Neapel, ii. (1881) pp. 305–71.

an alphabetical index of species and synonyms, a bibliographical list, and an index of authors.

Metamorphoses of Cassiopeia borbonica.*—Professor G. Du Plessis has observed ova of what he believes to be this species, develope into a fixed Scyphistoma, after passing through a free Planula-stage. Other larvæ of similar appearance, which had already attained the Scyphistoma-stage, were studied by him at the Naples Aquarium, and were seen in the middle of October to divide metamerically into segments, forming the well-known Strobila-stage. The segments soon became detached, constituting free Ephyræ of a similar, but paler, yellow tint to that of the adult of the above species, but differing from it in having four simple and suckerless, instead of eight ramified arms, and in having the margin of the umbrella much more deeply notched. In this instance also, the attempt to rear the adult failed, but as the only other species whose stages resemble these, has quite a different Ephyra, there seems good ground for believing that we have here the full metamorphosis of a Medusa, supposed hitherto to develope ametabolically. In the agreement of its physiological arrangements with those groups with which it has hitherto been classed, it affords an argument in favour of the morphological correctness of the present classification.

Development of Geryonopsida and Eucopida.†—Professor C. Claus states that in an aquarium containing sexually mature specimens of *Octorchis gegenbauri*, *Irene pellucida*, and *Æquorea forskalea*, he saw small polyp-stocks which presented great resemblance to *Campanulina;* the elongated hydranths were placed on branched stolons, the periphery of which was invested by a more or less distinct periderm. There was a conical retractile proboscis, and the base of the contractile tentacles was surrounded by a delicate ectodermal fringe. Hydrathecæ were, however, altogether wanting; this and other differences induce the author to call this form *Campanopsis.* The medusa-buds arise on the middle of the body of the polyp, where they form one, two, or, rarely, three transverse rows; they appear as bilaminate rounded projections, the base of which soon grows into a long cylindrical stalk, with a vesicular endoderm. Before the formation of the subumbrellar cavity, the ectoderm gives rise to a layer of flat cells, which form the theca, and give rise to a closed mantle-covering. The manubrium is formed from a central elevation; the radial vessels give rise to outgrowths, which are the rudiments of the primary marginal tentacles. In alternate rays, as well as between these and the primary tentacles, marginal vesicles become developed with small intermediate thickenings—the rudiments of fresh marginal filaments. When, therefore, the medusa is set free, it has two long tentacles and eight adradial marginal auditory vesicles. These last, which are relatively large, contain each a single otolith. At this point, unfortunately, the author's direct observations cease, but he adduces reasons for believing that this *Campanopsis* is an *Octorchis.*

* Bull. Soc. Vaudoise Sci. Nat., xvii. (1881) pp. 633-8 (1 pl.).
† Arbeit. Zool. Inst. Wien, iv. (1881) pp. 89–120 (4 pls.).

In some notes on the development of *Irene pellucida*, which is so common in the Adriatic from October to March, Claus states that it is possible that the polyp-form of this Medusa is a *Campanulina*. The first rudiment of the tentacles appears as an outgrowth, presenting brownish granular concretions, and having a pore at its tip; these pores are looked upon as being the orifices for subjacent glands, which probably have the function of renal organs, and which are formed by the endodermal investment of the adjacent portion of the circular vessel; by direct observation one may convince oneself that the brown granules and refractive concretions do escape by these pores to the exterior. The genital products appear to become matured in specimens of very various sizes. Some notes on *Phialidium variabile* complete the paper.

Fission of Phialidium variabile.*—Dr. M. Davidoff states that he has observed in this Leptomedusa that a second stomogastrium becomes formed at the base of the stomach as a small downwardly projecting bud; this happens before the tentacles are all developed. The bud gradually grows, and after some time a mouth breaks through. The whole medusa now commences to elongate, and the stomogastria occupy the centres of the ellipse; two radial canals now open into each stomach and between the two mouths there is an intergastral canal. After these and other changes are effected, the creature is ripe for fission; the plane of division lies between the two stomogastria, and almost always at right angles to the long axis of the ellipse; the constrictions deepening, the medusa is divided into two nearly equal halves. In some cases there is a third stomogastrium developed. The author reminds us that Kölliker, many years ago, noticed a process of fission in *Stomobrachium mirabile*.

Crambessa tagi.†—Professor R. Greef points out that this Portuguese Medusa affects the mouths of rivers, and makes its way into landlocked bays. He has found a wide vessel running within the oral fold; the two pairs of vascular branches which are given off from the short central transverse vessel, open, together with the eight arm-vessels, in the central cavity; the outgrowths above these central oral vessels have just the same structure as the lobes of the arms, into which they pass directly, and may therefore be regarded as "sucking knobs" or oral frills. Each of the eight arm-vessels divides into four longitudinal vessels, one of which is median; the three peripheral ones are connected by transverse anastomoses with the axial, and give off branches to the appended lobes.

The eight sensory organs agree in their external and general internal structure with those of the Hertwigs' second group of Acraspedota; the terminal network, in which the crystals lie, is regarded by the Hertwigs as being formed from the vessel which runs along the arm; Greef, however, thinks that this plexus is formed from the mesoderm, while the nerve-band breaks up into a fine nucleated plexus, which makes its way into the meshwork which

* Zool. Anzeig., iv. (1881) pp. 620–2.

† Ibid., pp. 568–70.

supports the crystals, and so comes into contact with them. In the upper wall of the terminal knob the author was able to detect an ocellus.

Sexual Cells of Hydroida.*—A. Weissmann finds that these are ectodermal in origin, but he allows that in some cases they are developed in the endoderm, and that in others the spermatozoa are ectodermal and the ova endodermal in origin; and he also recognizes the cœnosarcal origin of the elements in some cases. Together with this cœnosarcal origin, there may be development from cells situated in the sexual buds (*blastoid* origin), and *Hydrozoa* may therefore be spoken of as *cœnogenous* (abbreviated from cœnosarcogenous), or as *blastogenous;* and the author insists on the correctness of the view that in some cases the germ-cells are not developed until the medusa is completely formed.

The chief object of the present communication is to demonstrate that the sexual cells which arise in the cœnosarc are normal productions of great significance, and that in all such cases the cœnosarc and not the gonophores is to be looked upon as the true seat of the cells; and, further, to show that this mode of reproduction is very common, there being entire families in which the ova are so formed; while there are others in which the testicular products also are so developed. Of the latter, *Plumularia* (e. g. *P. echinulata*) is an example, for in it the cells are developed in the endoderm, principally of the trunk portion, but often also at the base of the lateral branches of the cœnosarc. The formation of the male and female gonangia is described in detail, and shown to be similar for both.

Gonothyrœa loveni is the first example of the Campanularidæ, and here the male elements are ectodermal, and arise, not in the cœnosarc, but in the gonophores, from an invaginated set of ectodermal cells. The ova, on the other hand, are formed from the endoderm of the cœnosarc and of the branches. In *Eudendrium ramosum* they are both formed from the endoderm, but the male elements are of blastoidal and the female of cœnosarcal origin. In *Cordylophora lacustris*, as Schulze was the first to show, the ova are cœnosarcal and ectodermal; the origin of the male elements has not been accurately worked out.

We find, then, certainly that in most (cf. next note) polyps with fixed gonophores the ovules do not arise in the gonophores but in the cœnosarc, and their appearance is the condition of the formation of a gonophore, into which they migrate. There is more variation in the male products, which do not appear to be so constantly cœnogenous; where, however, they are so, the development of the gonophore and the migration of the testes into them is essentially similar to that of the ovaries.

Spermatozoa of Hydrozoa.† — A. de Varenne has examined *Campanularia flexuosa*, *Gonothyrœa loveni*, and *Podocoryne carnea*, in which are found respectively a fixed gonophore, a demi-medusa, and

* Ann. Sci. Nat. (Zool.), xi. (1881) art. 6, 33 pp. (3 pls.).
† Comptes Rendus, xciii. (1881) pp. 1032–4.

a free medusa. In all cases the mother-cells do not appear in any part of the gonophore, but in the cœnosarc. Taking the first-named species, he found that before the appearance of any gonophore large highly-refractive cells appear in the endoderm of the cœnosarc; the presence of a certain number of these mother-cells determines the formation of a gonophore. Very soon the primary mother-cells multiply with great rapidity, and the daughter-cells, which are much smaller, form a horseshoe-shaped testicular mass, which, growing rapidly, ceases to form part of the endodermic wall, owing to the reconstitution of the unaltered endodermal cells, which now form a continuous layer below it. This explains the origin of the statement that the testicular cells are ectodermic in origin. There is, further, a great similarity between the development of the male and female elements. The author thinks that there is no true alternation of generations.

Porifera.

Attempt to Apply Shorthand to Sponges.*—The system here elaborated by Dr. G. C. J. Vosmaer is an extension of that first introduced by him in a paper on the *Desmacidinæ* of the Leyden Museum,† and its object is to give shortly the characters of a sponge by symbols which denote its several spicules. In the present scheme he tries to make his system of symbols so elastic as to admit almost any possible combination of characters in a spicule. Of course it is only applicable to sponges which have spicules, and does not take account of the *Carnosa* or the Horny Sponges; neither does it take account of the *proportions* (though the worker may readily add these himself); the author admits that it is not applicable to all cases, but claims for it the recommendation of saving some time and trouble in description. It is impossible to give here all the full formulæ used, so that in most cases only the abbreviations are given, which can be combined according to the requirements of different cases, and may help students of sponges to arrange for their own use, at any rate, methods of expressing shortly the often complicated spicular complements which may be met with. Dr. Vosmaer has used it for three years.

For *monaxial* (i.e. linear) spicules are used:—*tr* (truncate) = blunt-ended; *tr tr* = blunt at both ends, but not to same extent; *tr ac* (acute) = blunt at one end, pointed at the other (acuate, Bowerbank); *ac ac* = doubly-pointed, to different extents. Where the forms of the ends are similar, the formula is tr^2, ac^2, &c.; tr^0 *tr* = clavate or spinulate cylindrical, and tr^0 *ac* stands for the common spinulate or "pin-like" form; *f* = fusiform, *sp* = spined. Combinations of these signs supply formulæ for the thirty-two modifications of *straight* monaxial spicules. For *curved* forms of the same group the following abbreviations are used. An inverted V ($\wedge$) for the tricurvate acerate, an S on its side (∽) for the bihamate; the same with two lines drawn across it, so as to make it resemble the sign for a dollar, stands for trenchant contort bihamate; *anc* is anchorate, anc^3 is tridentate

* Tijdsch. Niederl. Dierk. Vereen., v. (1881) pp. 197–206 (1 pl.).
† See this Journal, iii. (1880) p. 661.

anchorate, anc^2 3 being tridentate equi-, and *anc anc* 3 tridentate inequianchorate; *anc* 2 is bidentate anchorate. *Rut* (rutrum, a shovel) palmated anchorate.

For the *Hexactinellid*, or, as Vosmaer prefers to call them, *Triactinellid*, types (those with three distinct axes), the general denomination is *ha* (initials of ἐξ and ἄξων); the different radii are designated by R or r; thus when four of the six rays are small and two large, the formula for the spicule is $(4\,r + 2\,R)$; *sp* may be added for spined. Where the spicules are fixed, i.e. skeletal, a line is drawn over the formula; thus the skeleton spicule of *Farrea* becomes *ha* $(\overline{4\,R + 2r\,sp})$; but the "fir-trees" of *Hyalonema*, &c., become *ha* $(4r + R\,f\,sp)$.

For *Tetractinellid* forms the general sign *ta* is used (τέσσαρες, ἄξων); in the common case in which one ray is longer or shorter than the rest, this odd ray is termed M (manubrium), and the others d (dentes); if these are bifurcate, *bif* is added to d. For the angles, that which M makes with the three d's—almost the only angle which varies—is termed ϕ; $>$ is *greater than*, $<$ is *less than*. A triradiate, being reckoned as a tetractinellid with one ray aborted, is expressed by *ta* $(M = 0)$. Thus porrecto-ternate of Bowerbank is *ta* $(\phi > 90°)$, patento-ternate is *ta* $(\phi = 90°)$, recurvo-ternate $(\phi < 90°)$; bifurcated-ternate is *ta. d. bif.* If necessary, such a formula as *ta* $(\phi > 90°)$ *d. bif* $(d' > d < M)$ could be used, where the three rays are bifurcate and of different sizes, but less than the odd ray.

Polyaxial forms, i.e. globates and stellates, may be termed *gl* (globulus) or *st* (stella), globo-stellates (with large ball for a centre) *gl. st.* For the spiral or double stellate (e.g. of some *Suberitidæ*), st^2 is employed.

Protozoa.

Flagellata.*—J. Künstler states that in an incubating chamber *Cryptomonas ovata* germs found at different stages in development presented the following characters. The less advanced were formed by a nucleolus surrounded by a layer of protoplasm; soon one of their poles developed more rapidly than the other, and elongated. After it had reached a certain size it gave rise at its free extremity to an axial cord of protoplasm, which constitutes the first stage of the digestive tube. Here there appear some large vacuoles, which divide and rapidly multiply, and soon a cavity commences to be developed in the body, beginning as a lateral space, one on either side. In *Chilomonas paramœcium* there is, similarly, a vestibule to the digestive tube, an antero-lateral constriction, locomotor, striated, and other prehensile flagella, a stomach with granular walls, an intestine terminating in an anus, four tegumentary layers, and a nucleus with several nucleoli, whence is given off a tube which dilates into the incubating chamber in which the germs are developed. In *Chlamydomonas pulvisculus* there are four, and not two, striated flagella, which are inserted around an orifice leading into a small cavity, and giving off delicate tubes to the contractile vesicles.

A new species is *Astasia costata*, the ribbed form of which is due

* Comptes Rendus, xciii. (1881) pp. 746–8.

to the presence in their integument of regular rows of starch-grains. In this form the digestive apparatus consists of a narrow œsophagus, a large gastric pouch, the walls of which were not detected, and an intestine leading to an anus. A new generic form is represented by *Künckelia gyrans*, which is a fresh-water *Noctiluca*. The body is capable of elongation, and so is enabled to creep about. There is an enormous tentacle which exhibits very active movement when the animal is swimming. Under its cuticle there are two muscular layers, which are continued into the tentacle. The mouth appears to lead into a very large cavity. No phosphorescence has yet been observed in this form.

Infusoria Parasitic in Cephalopods.*—In an elaborate memoir, A. Foettinger enters more into detail into some of the characters of these forms.† In dealing with the suspected muscular fibrils, he says that in optical section they reveal themselves as bright spots, set at equal distances from one another, and placed near the cuticular envelope. They give rise to the appearance of a transverse striation, and these striæ, of which there are two systems, become both visible when the cover-glass is compressed on the animal. The differences in the position of the fibrils is due to a difference in their state of contraction; for as they contract their obliquity diminishes, and the part of the body which contains them becomes shorter and wider. In one case the author observed in *Benedenia* a nucleus extending throughout the whole length of the body. He regards the nucleus, the characters of which have been already detailed, as not forming a fixed element, but one gifted with the power of amœboid movements. *Opalinopsis sepiolæ* was on one occasion observed to conjugate and reproduce while in sea water, so that in this case we can see how the parasite may pass from one Cephalopod to another.

Parasites of the Echiurida.‡—Professor R. Greef describes *Conorhynchus gibbosus* nov. gen. et sp., a large Gregarine to which he previously gave the name of *Gregarina echiuri*. The creature, which lives in the digestive canal, is nearly always found, when adult, in conjugation. Each individual forms a hemispherical disk, and its surface is provided with a number of conical and warty projections. At the anterior end there is a considerable process which appears to serve as an organ of attachment; the form is completely transparent owing to the great development of vacuoles. There is a large nucleus. In size each adult is about 1 mm. long and 1 mm. broad. In the youngest stage observed, the Gregarine had the form of a *Monocystis agilis*, and the internal substance was opaque and darkly granular. *Distomum echiuri* n. sp., found in the seminal vesicles of *Echiurus pallasi*, is 2 mm. long, and is continued forwards anteriorly into a proboscidiform process. *Nemertoscolex parasiticus* n. gen. et sp., is a Nemertine of about 3 mm. long, found twice in the cœlom of *E. pallasi*, in the male as well as in the female.

* Arch. de Biol., ii. (1881) pp. 345–78 (4 pls.)

† See this Journal, i. (1881) p. 902.

‡ Nova Acta Acad. Cæs. Leop.-Carol. Germ. Nat. Cur., xli. ii. (1880) pp. 128–131, with figs.

BOTANY.

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

Origin of the Embryo-sac and Functions of the Antipodal Cells.*—After referring to the views on these subjects already published by Warming, Vesque, Strasburger, Fischer, Ward, and Treub,† L. Guignard details a series of observations of his own on a variety of plants, to determine some of the controverted points.

As a type of the Mimoseæ, in which the phenomena are remarkably uniform, he takes *Acacia retinoides.* At the summit of the nucellus, beneath the epidermis, an axial cell, somewhat larger than the adjoining ones, divides into two superposed cells; one, the origin of the cap (*calotte*) in Dialypetalæ, in immediate contact with the epidermis; the other Warming's primordial mother-cell of the embryo-sac, situated at a greater depth; these he calls the apical and subapical cells. The apical cell gives birth to a tissue which is generally reduced to three broad cellular layers. The subapical cell rapidly enlarges, and becomes segmented horizontally in the basipetal direction, dividing thus into three superposed cells each equal in size to the mother-cell. Of these the lowest is alone the true mother-cell of the embryo-sac, enlarging at the expense of the others and of the lateral nucellar tissue. The nucleus increases in size, and becomes surrounded at first by granular protoplasm, then by grains of starch, which finally often entirely fill up the cell-cavity. Resorption soon commences in the two superposed cells; their nuclei lose their sharp outline, the cell-walls disappear, and the entire protoplasm has the appearance of a homogeneous and refractive mass, the nuclei becoming indistinguishable; finally the whole substance of these cells is absorbed in the development of the lower mother-cell.

This process is subject to certain variations; but it is always the lower cell which becomes the mother-cell, and absorbs the others. The starch-grains disappear during the formation of the eight nuclei which give rise to the synergidæ, the oosphere, the antipodal cells, and the two polar nuclei which coalesce in order to form the secondary nucleus of the embryo-sac.

In the Cæsalpinieæ the apical cell generally gives rise to a thick tissue which remains for a considerable time, even after impregnation. Variations occur in the subsequent development; and these are greater among the Papilionaceæ, not only in genera of the same tribe, but even in species of the same genus. In this order the apical cell gives rise only to two superposed cells; the subapical cell remains undivided, increases early, and displaces the others.

As a general result, whatever may be the differences in the origin and number of the cells which constitute the axial row of the nucellus, it is the inferior cell only which is the true mother-cell of the embryo-

* Bull. Soc. Bot. France, xxviii. (1881) pp. 197–201.

† See this Journal, ii. (1879) p. 903; iii. (1880) pp. 107, 979; i. (1881) pp. 260, 620.

sac; there is never any coalescence between two adjoining cells. In all the Leguminosæ the synergidæ and oosphere, the antipodal cells, and the secondary nucleus of the embryo-sac, are formed in the well-known mode. The antipodals often disappear after impregnation, in consequence of the resorption of the subjacent nucellar tissue. Their function, which is still very doubtful, seems to terminate shortly after their formation. In other orders of plants, on the contrary, they increase considerably, even after impregnation. As in the majority of Angiosperms, there are no anticlinals, the mother-cell of the embryo-sac being the last of the row.

The presence of two nuclei in one or more cells, as in *Cercis*, does not furnish any real analogy with the special mother-cells of pollen-grains, because their division-walls are never completely resorbed.

Antipodals with several nuclei occur in some Ranunculaceæ, as *Clematis* and *Hepatica triloba*. The cells are always three in number, and are inserted at the base of the embryo-sac, to which they are attached by a kind of pedicel. Each of them has a nucleus containing at first a single nucleolus. Long before impregnation two nucleoli appear (in the hepatica) isolated in the substance of the nucleus; there is an internal line of separation between them corresponding to a slight depression on the surface, which gradually deepens, and finally divides the mother-nucleus into two parts, in which the same phenomenon may then be repeated, though this is not usually the case. The whole then presents the form of four segments, in which the nucleoli multiply; and the protoplasm itself may be divided into five, six, or even eight rounded fragments. The nucleoli do not elongate into an hour-glass form, nor does the substance of the nucleus present any median constriction, as is generally the case in fragmentation; they are rather granulations of the nuclear protoplasm, which soon attain a considerable size. Finally the mother-nucleus is filled with granular nucleoli, and becomes enveloped in the protoplasm.

There appears, therefore, to be a special process of fragmentation in organs whose function is completed, and which may be regarded either as an organic residuum or as a degraded prothallium.

Polyembryony in Mimoseæ.*—According to L. Guignard, polyembryony is a not uncommon phenomenon in the Mimoseæ, especially in *Schranckia uncinata* and *Mimosa Denhartii*, and is allied, in the former case, with other abnormalities of structure.

In *S. uncinata* the tigellum is furnished, towards its extremity, with an appendage of variable form, lobed, and descending below the cap which clothes the embryonal radicle. The internal structure of this appendage presents several interesting peculiarities. In addition, several embryos, formed of an internal normal structural axis, and furnished, or not, with this appendage, present three or even four foliaceous cotyledons of equal length folded longitudinally in various ways. When the number of cotyledons is three, they occupy the angles of an equilateral triangle, and one of them is inserted at a

* Bull. Soc. Bot. France, xxviii. (1881) pp. 177–9.

different level from the others; when the number is four, they are arranged in two opposite pairs at different levels. Instead of a single tigellum, there are often two of equal size, united in growth during the greater part of their length, but distinct towards the base. One of these axes occupies the normal position, the other being applied to it laterally.

The appendage is undoubtedly a reserve of food-material. When a seed possessing it germinates, it is exposed along with the radicular extremity, increases for some time after the rupture of the testa, then gradually loses its starch, which it gives up to the embryo, and finally dries up and perishes.

Resistance of Seeds to extreme Cold.* — E. Wartmann has exposed fresh-gathered Spanish chestnuts for nearly two hours to a cold of at least -110°, derived from a mixture of sulphuric ether and solid carbonic acid, each seed being carefully wrapped in thin tinfoil, so as to prevent the surface coming into contact with the ether. The chestnuts were then planted in the soil; they germinated and developed in every respect as successfully as those which had not been exposed to the cold. The power of resistance to extreme cold appears, indeed, to be a very general property of seeds.

Mechanical Contrivances for the Dispersion of Seeds and Fruits.†—A. Zimmermann has subjected to a fresh examination the structure of the seed-vessels of Gramineæ, Papilionaceæ, and Geraniaceæ, by the torsion of which the seeds are buried in the soil, especially in relation to the alternate turgidity and desiccation of the tissues. His conclusions, which are mainly in accord with those of C. and F. Darwin, are as follows:—

1. The hygroscopic torsion of the awns of Gramineæ is the result of the effort after torsion of the outer cells of the stereome, and of the strong contraction of its inner cells, which probably assist by the fact that when they swell they assume an oblique position. The micella of the former cells are arranged in spiral lines, those of the latter in oblique rings.

2. The effort after torsion of a single spirally striated cell is caused by unequal intensity of swelling and unequal firmness in the direction of the two systems of rows of micella. The swelling of an imaginary cylinder without thickness causes in general a torsion in the direction in which there is the strongest swelling. The radial swelling of a cylinder possessing thickness, causes, when it is strongest, a torsion in its outermost layers in the direction of less firmness; in the inner layers, one in an opposite direction. The most probable explanation of the fact that a cell in which the most strongly marked striations and pores are arranged in spirals inclined obliquely to the left, turns itself to the right when it swells, to the left when it dries up, is that on the one hand the swelling is strongest in a direction vertical to these striations and to that of the pores; on the other

* Arch. Sci. Phys. et Nat., v. (1881) p. 343. See Naturforscher, xiv. (1881) p. 276.

† Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 542–77 (3 pls.).

hand, the firmness is greatest in the direction of the rows of micella and of the pores.

3. The cause of the torsion of the legumes of *Orobus* and *Caragana* resides in the layer of resin, and is brought about in it by unequal contraction in the transverse direction, which is indicated by anatomical differences. The outer epidermis (and its anatomical strengthening in *Caragana*) acts only by increasing the strength of the mechanism, the vascular bundles of the margin detracting from its efficiency.

4. The torsion of the awns of *Geranium* is caused by unequal contraction of the cells in the longitudinal direction, these cells manifesting also differences in the form and direction of their pores. In the awns of *Pelargonium* the outer strongly developed epidermis effects the torsion by strong curvature, the direction of the torsion being rendered spiral by the tendency to torsion of the inner cells.

5. The violent expulsion of the seeds of *Oxalis* is not caused by turgidity, but by the energetic swelling of the cell-walls of the transparent outer layer.

Chemical Difference between dead and living Protoplasm.—The view maintained by O. Loew and T. Bokorny,* that living cells are chemically different from dead ones, in that living protoplasm shows an aldehyde nature by its power of reducing extremely dilute alkaline silver solutions, while dead protoplasm does not, has been the subject of an interesting discussion at the Berlin Chemical Society, when Herr Reinke denied the chemical difference, and insisted that at least a part of the reaction is due to a volatile substance of aldehyde nature which is very frequent in green cells, and which he is disposed to regard as formic aldehyde, the first product of assimilation of carbonic acid in the plant.

His opponents urged that they had carefully examined the distillation products of various species of Algæ and of germs without chlorophyll, but had quite failed to find any silver-reducing substance. Thinking, further, that they might have been misled by the action of sugar or tannin, they convinced themselves that cells reduce which have neither of these substances, and a living cell will easily reduce a very dilute silver solution which sugar and tannin fail to reduce. The intimate relation between silver-reducing power and life (in their opinion) is shown clearly by the fact that in whichever of many different ways cells of Algæ were killed, the reaction in question ceased with their death, and precisely at the degree of temperature at which life is extinguished. This is generally the case in killing by poison; strychnine alone being an exception, which is explained by the existence of a combination of the alkaloid with molecules of the active albumen.

Energy of Growth of the Apical Cell and of the youngest Segments.†—M. Westermaier commences a dissertation on this subject with an historical sketch. Naegeli and Schleiden attributed the causes

* See this Journal, i. (1881) p. 906.
† Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 439–72 (1 pl.).

of the form of any particular part of a plant to the individual cells, so that the individual cell plays a prominent part, and the behaviour of these determines the form of the organ. A different view is held by Hofmeister, Sachs, De Bary, and Hanstein, who regard as the primary fact the form of the organ itself, which then determines the form and mode of division of the cells. An intermediate position between the two is held by Schwendener; the arrangement of the cells and the directions of the dividing walls being, according to him, determined by two variable factors:—(1) by the individuality of the cell; (2) by the form or complete growth of the entire organ, to which Schwendener also attributes a share in the arrangement and growth of cells. The final position of the walls and arrangement of the cells is often also influenced by pressure.

In order to determine the relative energies of growth of the cells of the apical region, the author proposes the following theoretical considerations:—

1. "The apical cell displays the same activity with regard to increase in volume during successive stages." By a stage the author means the time which elapses between the formation of a division-wall in the apical cell and the formation of the next following division-wall.

2. "The successive segments display an equal activity with regard to increase in volume during successive stages." In this connection the relationship is investigated between the volume and the projection of the lateral profile of a triangular pyramidal and of a two-edged apical cell.

After these theoretical propositions, a comparison is made of the energy of growth of the apical cell in *Dictyota* (according to Naegeli), *Hypoglossum Leprieurii* (Naegeli), *Metzgeria furcata* (Goebel), *Salvinia natans* (Pringsheim), *Equisetum arvense* (Cramer), *E. scirpoides* (Reess), and *Selaginella Martensii* (Pfeffer).

The general result is stated as follows:—The maximum of increase in volume lies in general either in the apical cell itself or in the youngest segments. If we look only at the region which includes the apical cell and the four youngest segments, in none of the cases mentioned above is the increase of volume least in the apical cell.

Action of Nitrous Oxide on Vegetable Cells.*—Prof. W. Detmer has tried a series of experiments on the influence on vegetable tissues of nitrous oxide gas, which he states may, to a certain extent, replace oxygen in the respiration of plants. For this purpose he took pains to obtain the gas absolutely pure, and carefully to exclude every trace of atmospheric air. The main results of his experiments, made on *Triticum vulgare* and *Pisum sativum*, are as follows:—

1. When grains of wheat or peas are made to swell in water which has been boiled and allowed to cool, and then placed for a considerable time in contact with pure nitrous oxide, they lose their power of germination.

* SB. Jenaisch. Ges. Med. u. Naturwiss., 1881, July 1. See Bot. Ztg., xxxix. (1881) p. 677.

2. If their contact with the gas is not so long, say from one to three days, they do not entirely lose the power of germinating; the embryo will begin to develope under normal conditions.

3. A longer contact with the gas kills the cells.

4. In a mixture of two parts by measure of nitrous oxide and one part of atmospheric air, the power of germination of peas is very greatly weakened.

5. If peas have been made to germinate under ordinary conditions, and then brought into pure nitrous oxide, no further development whatever of the root and stem takes place.

6. In pure nitrous oxide no geotropic or heliotropic curvatures take place.

7. Etiolated parts of plants do not become green in the light if surrounded by an atmosphere of pure nitrous oxide.

8. A number of experiments prove that vitally active cells are not able to decompose nitrous oxide; and that they therefore have no power of using its oxygen for the purpose of respiration.

Chlorophyll and the Cell-Nucleus.*—G. Schaarschmidt makes the following observations:—

1. Division of chlorophyll. The mode of division of the chlorophyll-grains resembles that of the nucleus, and takes place either directly by constriction, or indirectly by division with formation of threads. All green chlorophyll-grains divide in one or other of these ways, as does also the endochrome of diatoms, as, for example, the coccochrome of *Odontidium vulgare*, and the placochrome of *Himantidium pectinale*.

2. Hypochlorin occurs also in the Cryptophyceæ and diatoms. When *Nostoc*, *Microcoleus*, *Merismopedium*, and *Oscillaria*, had been treated for two days with concentrated, and then for four days with dilute hydrochloric acid, and preserved in it, three, four, or more minute rusty-brown masses made their appearance on the surface of the cells, which showed the characteristic properties of hypochlorin. The endochrome of diatoms treated in the same way becomes dirty green, and assumes a spongy structure, hypochlorin appearing at the margins in the form of irregular brown masses. This occurred in *Cymatopleura Solla*, *Himantidium pectinale*, *Synedra splendens*, *Pinnularia viridis*, *P. radiosa*, &c., and especially in *Synedra ulnæ*. The reactions were not, however, successful in every individual.

3. The cell-nucleus of *Nostoc*. A small round body was observed in the cells of *Nostoc*, usually in contact with the division-walls, and which showed beautiful phases in the division of the cells. When the cell has elongated and is ready for division, this body parts in the middle, a colourless central zone being thus formed in the midst of the colouring substance. When oblong cells are placed in coloured alcohol-material, the nucleus is constricted; the constriction becomes gradually deeper, and a furrow appears on the outside of the cell.

* Schaarschmidt, G., 'Morphology of Chlorophyll and of the Vegetable Cell-nucleus' (in Magyar); with drawings and a photogram. 56 pp. Klausenburg, 1881. See Bot. Centralbl., vii. (1881) p. 263.

Finally the daughter-nuclei divide, and are kept together only by a narrow bridge; when the cell-division is complete, these nuclei are found again on the division-walls. The diameter of these minute bodies is only from 0·5 to 0·6 μ; their behaviour when dividing and towards colouring reagents is opposed to the view that they are chromatin or microsomes.

Influence of Warmth of the Soil on the Cell-formation of Plants.*—E. Prillieux finds that the effect of warmth in the earth is to cause a hypertrophy of the interior of the stem in a young plant; when closely examined, this is found to be accompanied by multiplication of the cell-nuclei. In the bean and the pumpkin, when the seeds have germinated in earth of 10° higher temperature than the surrounding air, cells are often found containing two or three massed or isolated nuclei, which may be either equal or unequal in size, and of various shapes. This multiplication is effected by fission of the nuclei, which generally contain several nucleoli, up to the number of four or five, of very different forms and sizes, and sometimes obviously constricted preparatory to their division. At the time of division, a boundary wall placed either opposite a large nucleus or between two closely apposed small ones, divides the nucleus into two halves; these two halves swell up, and the whole has usually a kidney-like shape. The process is completed by prolongation of the grooves of the surface through the dividing wall.

Growth of Starch-grains by Intussusception.†—In replying to the attack by Schimper ‡ on the theory of the growth of starch-grains by intussusception, C. Naegeli points out that there are three different conditions of the "micellar" constitution of the cell-wall (using the term "micella" to distinguish the physical ultimate elements of a substance from the chemical molecules or atoms) viz.:—(1) The living condition of the cell-wall, when it is in immediate contact with living cell-contents; in this condition the cell-wall is more or less strongly coloured by aniline pigments, while the contents do not take up any of them. (2) The cell-wall is in a naturally dead state when the living contents separate from it, or when they die while still remaining in contact with it; in this condition the cell-wall does not take up any pigment, while the contents become coloured; and if the cell-wall was coloured when living, it loses its colour on passing into the dead state. (3) The swollen condition is caused by the action of alkalies or acids, by long boiling in water, or by lying for a sufficient time in cold water; in this state the cell-wall is again capable of being coloured.

In every stage of its growth the starch-grain is a material system surrounded by a watery fluid, and saturated with water, the tensions of which are in a condition of equilibrium. When the grain becomes dry, crevices are formed, a proof that the equilibrium is by this means

* Kosmos, viii. (1881) pp. 63–4.

† Bot. Ztg., xxxix. (1881) pp. 633–51, 657–77; also SB. Akad. Wiss. München, xi. (1881) pp. 391–438.

‡ See this Journal, i. (1881) p. 909.

destroyed; and the fissures have a radial direction crossing the layers at right angles, a proof that more water is lost in the tangential than in the radial direction, and that the total quantity of water deposited in the tangential direction is greater. When substances which cause artificial swelling act slowly on the naturally saturated starch-grain, it increases in volume, radial fissures being again formed, a proof that during this process more water is deposited in the radial than in the tangential direction. He argues, on mechanical grounds, that the tensions found in starch-grains can be accounted for only by intussusception, and that these tensions can cause the secretion of the soft nucleus and the soft layers only on the supposition that intussusception is at the same time taking place.

Collenchyma.*—H. Ambronn has carefully investigated the history of development and the mechanical properties of collenchyma in a number of instances, especially in *Colocasia esculenta* and other allied aroids, and in Umbelliferæ and Piperaceæ.

With regard to the history of its development, these observations confirm the statement of Haberlandt that, as in the case of bast, no uniform origin can be ascribed to the collenchyma, but that it varies in every possible way. Also that the grouping and arrangement of the cells is the result, in the first place, of purely mechanical and not of morphological laws; and that, when definite relationships exist between the collenchyma and the mestome (in Schwendener's sense of the term), these relationships are explained by the history of development. These relationships occur in those plants in which the origin of the collenchyma and of the mestome is uniform, and in those in which projecting ridges or angles are produced by the formation of vascular bundles at the periphery, groups of collenchymatous cells being developed in them in consequence of their centrifugal tendency.

As regards the structure of the collenchymatous cells, they have in general a prosenchymatous character. They are moderately long, often 2 mm. or more, and very frequently manifest subsequent segmentation by delicate division-walls. They are always filled with sap, but contain little or no chlorophyll. The longitudinal walls of the cells have usually longitudinal crevice-like pores.

Other collenchymatous cells, on the contrary, have more of a parenchymatous character, and have usually been formed by secondary collenchymatous thickening of parenchymatous cells.

The cell-walls of collenchyma are always coloured a bright blue by chlor-iodide of zinc, but are not coloured by the action of phloroglucin and hydrochloric acid. Their power of swelling in water is not so strong as has usually been supposed; the cells are seldom contracted by more than $\frac{1}{2}$ per cent. of their entire length by the application of desiccating reagents.

The elements of the formative tissue out of which the collenchymatous cells are subsequently developed are partly cambial, partly belonging to other meristematic portions. But very often there is no special formative tissue; the collenchymatous thickening taking

* Pringsheim's Jahrb. wiss. Bot., xii. (1881) pp. 473–541 (6 pls.).

place only as a secondary result in parenchymatous cortical cells. But we have not yet sufficient knowledge to divide collenchymatous tissue on this ground into subsections.

Collenchymatous cells differ in one very essential point from true bast-cells. While in the latter the limit of elasticity nearly coincides with absolute firmness, in collenchyma the elasticity is overcome by a comparatively small strain, the firmness only when the strain is increased three or fourfold.

Since, therefore, a permanent elongation results from the tension to which the collenchyma is subjected in the young turgid internodes and leaf-stalks, but no rupture, it is clear that this tissue can, in consequence of its great absolute firmness, afford the necessary assistance to the intercalary construction of these organs, without however interfering with their growth in length. That the growth in length of the collenchyma itself is a consequence of this tension caused by the turgidity of the other parts of the tissue, can scarcely be doubted. But whether the permanent elongation of the collenchymatous parts, caused by the passing of the limit of elasticity, plays any definite part in this process, must remain undecided in the present imperfect state of our knowledge of the processes of growth in the cell-walls.

Epidermis of the Pitchers of Sarracenia and Darlingtonia.*— Prof. A. Batalin has made a careful anatomical examination of the pitchers of *Sarracenia flava*, *purpurea*, and *variolaris*, and *Darlingtonia californica*. He finds that the lower region of the inner epidermis, the "detentive surface" of Hooker, has no cuticle; while all the other cells of the detentive surface have one, and especially the long stiff hairs. The inner region of the pitcher is of a uniform bright-green colour within and without; but this is true of the inner surface only so long as no insects have been captured; it then becomes brown, the green colour of the outside remaining. While on the green spots on the inside of the pitcher the moderately thick and nearly colourless outer walls of the epidermal cells are quite smooth, at the brown spots, where insects have come into contact with them, they have one or more irregular spots of a much lighter colour. Treatment with chlor-iodide of zinc causes these spots, but not the rest of the cell-walls, to turn blue.

This observation leads to the conclusion that the contact of an insect with the epidermal cells causes a change in the latter, which consists chiefly in the excretion, between the cuticle and the cellulose-wall, of a fluid, the nature of which has not been determined, but which probably has the property of dissolving albuminoids. It appears to act both mechanically and chemically upon the cuticle, forcing it outwards, and finally rupturing and almost entirely destroying it. A change is at the same time taking place in the cellulose-wall. It assumes a brown colour, and in addition becomes partially mucilaginous.

The author also describes a peculiar sieve-like disk between the epidermis and the glands of *Pinguicula vulgaris*.

* Acta Hort. Petrop., vii. (1880) pp. 343–60 (1 pl.). See Bot. Centralbl., vii. (1881) p. 327.

Laticiferous Vessels.*—D. H. Scott has investigated the structure and development of the laticiferous vessels, chiefly in *Tragopogon eriospermus;* also in *Scorzonera hispanica, Taraxacum officinale,* and *Chelidonium majus.* The following are the most important results:—

The laticiferous vessels are developed out of rows of cells, the transverse walls of which have been gradually absorbed, and, when two vessels lie side by side, the lateral walls also partially. The resorption usually takes place at an early period; in seedlings during the first stages of germination; in the secondary cortex shortly after the cells in question have separated from the cambium.

The connection between distant laticiferous vessels is brought about in two ways; either by rows of cells that run transversely coalescing with one another, or by protuberances which unite in their growth, and which finally form canals similar to those of the Conjugatæ.

Even before the first septa are absorbed, the cells are characterized by special contents, of which latex is probably a constituent.

Epidermal System of Roots.†—L. Olivier has made a careful study of the epidermal tissue in the roots of Vascular Cryptogams, Gymnosperms, Monocotyledons, and Dicotyledons, dividing the latter into two classes, those in which the secondary vascular system originates early, and those in which it originates late. The following are the general results:—

The piliferous layer of the root does not correspond to the epidermis of the stem, but rather to one of its hypodermal layers. It is this which gives birth to the "veil," a system of layers of cells proceeding from the piliferous layer; as it peels off, the subjacent or epidermoidal layer most generally assumes the anatomical character of the epidermis, and the same physiological functions.

The secondary tissue of the epidermal system of the root is either parenchymatous or of a corky nature. The secondary epidermal parenchyma proceeds from a peripheral layer of the central cylinder; it attains considerable development in Dicotyledons with early secondary vessels, and in Gymnosperms; there is none in Vascular Cryptogams, in the great part of Monocotyledons, nor in Dicotyledons with late secondary vessels.

In Gymnosperms and in Dicotyledons with deciduous primary bark, the cork is derived from the pericambial layer. It is composed of tabular cells, the radial walls of which are very short.

In woody Dicotyledons with late secondary vessels, in Monocotyledons, and in Vascular Cryptogams, the production of cork takes place in the external zone of the cortical parenchyma; the cork is here composed of cubical cells.

In any particular species, the zone of the root where the cork appears depends on the transverse diameter of the organ, and on its physical surroundings. The diameter being the same, the cork is generally earlier and more abundant in the aerial than in the underground roots.

* Scott, D. H., 'Zur Entwickelungsgeschichte der gegliederten Milchröhren der Pflanzen.' Inaugural Dissertation. 23 pp. Würzburg, 1881.

† Ann. Sci. Nat. Bot., xi. (1881) pp. 5–129 (8 pls.).

Passage from the Root to the Stem.*—R. Gérard concludes from a careful examination of the facts connected with this subject that a "collar" does not exist as a geometrical expression. Between the root and the stem is a region, more or less extensive, where the elements of the root, advancing to the higher parts of the axis, become modified, gradually assuming the configuration, place, and importance which they possess in the stem. The transformation of each of the elements is independent of that of its neighbours, and may take place slowly or very rapidly. Hence the collar, considered anatomically from different points of view, presents the most variable aspects. The transformation of the epidermal system furnishes no guide to the limitation of stem and root; the change in the epidermis is one of the phases of the passage.

Using the term in its widest sense, the collar may commence in the upper part of the radicle and extend to the fourth internode, rarely passing the cotyledons, or it may be entirely localized in the radicle; it may occupy a part of the organ, and the whole or a part of the tigellum. Most often the passage is completely effected in the tigellum. The size of the collar is in proportion to the diameter of the plant.

No family characters can be drawn from the study of the collar; its peculiarities are constant only in the species. It is connected with the accommodation of the plant to its surrounding conditions.

Causes of Eccentric Growth.†—Dr. E. Detlefsen has investigated the cause of eccentric growth in thickness of woody stems and roots in a number of instances, and finds it attributable to the four following causes:—

1. Branches and axillary roots cause, at the point from which they spring, a diminution of the tension of the bark, and consequently an acceleration of the growth in thickness, which is most considerable where the surface of the lateral organ forms the smallest angle with that of the mother-organ.

2. Every diminution or increase in the tension of the bark is perceptible over a large extent in the longitudinal direction of the bast-fibres.

3. Every lateral pressure which causes curvature of the organs brings about an increase in the tension of the bark on the side which becomes convex, a diminution on that which becomes concave.

4. Convex surfaces cause an increase, concave surfaces a decrease, in the tension of the bark, which affects chiefly the different sides of curved branches and roots.

These influences may be exercised either in conjunction or separately.

Hydrotropism of Roots.‡—The term "hydrotropism" has been suggested for the tendency displayed by roots, when placed between a

* Ann. Sci. Nat. (Bot.,) xi. (1881) pp. 277–430.

† Detlefsen, E., 'Versuch einer mechanischen Erklärung des excentrischen Dickenwachsthums verholzter Achsen u. Wurzeln.' 13 pp. (1 pl.) Weimar, 1881.

‡ Bull. Soc. Bot. France, xxviii. (1881) pp. 115–21.

moist and a drier medium, to direct themselves towards the former, to an extent often sufficient to overbalance geotropism. As the result of a series of observations, M. Mer contests the view that hydrotropism is a special instinctive faculty of the root; he attributes the phenomenon to the retardation of growth consequent on an insufficient supply of moisture, a condition which may completely prevent the manifestation of geotropism.

Cause of the Swelling of Root-fibres.*—E. Mer and M. Cornu have observed that when the roots of growing plants are placed in coloured fluids, if the solution is too concentrated so as to check growth, each root-fibre swells near the apex, the swelling being often accompanied by a more or less decided curvature. M. Cornu attributes this phenomenon to the same cause as the swellings caused by phylloxera and by gall-insects, viz. not the special influence of a particular fluid, but tensions developed locally by any cause, and in many cases the arrest of development of an organ in course of elongation; the production of a fluid may, however, in certain cases co-operate with this.

Frank's Diseases of Plants.—The completion of this work, to the publication of the 1st part of which we have already alluded,† furnishes a very complete account of the various diseases and injuries to which plants are subject. It is divided into five sections, as follows:—1. The living and dead state of the vegetable cell. 2. Action of mechanical influences. 3. Diseases caused by influences of inorganic nature. 4. Diseases caused by other plants. 5. Diseases caused by animals.

Under the first head the author describes the phenomenon known as the "apostrophe" of the chlorophyll-grains. The normal position of the chlorophyll-grains he states to be in a layer especially next to those parts of the cell-wall which are not in contact with adjacent cells—on the outer side, therefore, of epidermal cells, and on walls that border intercellular spaces; and to this position he applies the term *epistrophe.* Certain unfavourable influences, as long-continued absence of light, wounds, &c., cause the chlorophyll-grains to lose this position, and group themselves along those cell-walls that are in contact with other cells; and this abnormal position he calls *apostrophe.*

The production of wens is thus described. The first cause is always a small wound in the periderm, which sometimes appears to be a crevice over a lenticel. Between the dried margins of the outer ruptured cortical layer there then projects a living new formation in the form of a light-brown cushion, which is either a round tuber or a long wheal, according to the shape of the wound; a cluster of smaller tubers often break out in addition from the bottom of the wound. When this cushion projects to a height of 1 mm. above the wound, it consists only of cortex and bast, not of wood; it is a hypertrophe of the cortex, enclosed in a young periderm. The parenchymatous

* Bull. Soc. Bot. France, xxviii. (1881) pp. 124–7.

† See this Journal, i. (1881) p. 273.

tissues of the cortex and bast form the greater part of this cushion. At its base and in the neighbourhood of the bast of the stem is a hard, horny tissue, consisting of extremely thick-walled cells, resembling the bast-fibres, but short, also nearly iso-diametric, also of sclerenchymatous cells of great size, their cell-walls so greatly thickened that the cavity has nearly disappeared, and with pit-canals. At a later stage the woody tissue is also enclosed in the hypertrophy. Nothing is said by the author about adventitious buds.

Among parasitic fungi causing diseases of plants, Frank includes species of Chytridiaceæ, Saprolegniaceæ, Peronosporeæ, Ustilagineæ, Uredineæ, Hymenomycetes, Discomycetes, and Pyrenomycetes; and describes the following new species, viz.:—*Saprolegnia Schachtii*, on *Pellia epiphylla; Ramularia Viciæ*, on *Vicia tenuifolia; Cercospora Phyteumatis*, on *Phyteuma spicatum;* and *Glœosporium Phegopteridis*, on *Phegopteris polypodioides.* The mycelium of *Agaricus melleus* he regards as the cause of the extensive vine-disease known in France as "blanc des racines." The sclerotial disease of rape-seed is caused by *Peziza sclerotioides;* and that of *Impatiens glandulifera* and other species of Balsamineæ by a fungus to which Frank gives the provisional name *Sclerotium Balsaminæ.* The lowest internodes of the stem lose their turgidity, become flaccid, and look as if they had been boiled; and the plant quickly dies. The tissue is penetrated by a mycelium on which are small black sclerotia.

A full account is given of the production of galls by *Phytoptus* and other gall-producing insects. The following description is given of the formation of the bag-shaped galls on the leaves of *Prunus Padus.* The insect probably in the first instance inflicts injuries which excite the production of the galls; but they only retreat into the galls at a later period when the care for their offspring comes into play. The same appears to be the case with *Erineum tiliaceum.* The insect could not be detected either at the spot where the injury is first made, or in the immature gall; not till the beginning of June, when they are found in abundance, with their eggs, in the galls. In the case of the lime the injury appears to act on both sides of the leaf.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Prothallium and Embryo of Azolla.*—Prof. S. Berggren has followed out carefully the development of the prothallium and embryo of *Azolla caroliniana.*

As in *Salvinia* the endospore splits, on germination, along its three edges. On escaping, the prothallium has the form of a slightly convex disk, consisting in the middle of several layers of cells, at the margin of only one, and separated below by a thin hyaline membrane from the large protoplasmic spore-cavity. Shortly afterwards an archegonium is formed near its centre, consisting of four cells enclosing the oosphere and of four neck-cells. If this archegonium is fertilized, no

* Lunds Univ. Arsskrift., xvi.; and Rev. Sci. Nat., i. (1881) pp. 21–31 (1 pl.).

others are usually formed, but if not a few others are subsequently developed. When quite mature the part of the prothallium which projects outside the spore is nearly hemispherical, and three obscure wings are produced by three longitudinal furrows. The cells contain chlorophyll.

The position of the oosphere with respect to the neck of the archegonium probably corresponds to that in *Salvinia*. After fertilization it is divided by the first oblique division-wall into a smaller upper cell facing the neck of the archegonium, and a somewhat larger lower cell filled with coarsely granular protoplasm. By successive walls vertical to one another and to the first division-wall, and parallel to its longitudinal axis, the embryo is then divided into octants. In each octant a wall next appears parallel to the first division-wall; and the entire embryo then consists of 16 cells, arranged in four parallel rows.

The four cells which lie at the upper pole are the rudiment of the foot. Of the four lowermost cells one is the origin of the apex of the stem, another developes into an organ resembling the first leaves, the two others are together the rudiment of the scutellum. In its subsequent growth the young apex of the stem follows the ordinary laws; only the bud is at first straight, and the characteristic curving upward of the cone of growth is a subsequent phenomenon. The leaves first produced are strongly concave, and, in contrast to the later ones, are not lobed. Some of the hairs which mark the upper side of the apex of the stem are formed at the same time as the first leaf. The scutellum originally encloses the bud as a crescent-shaped growth, the margins of which gradually approach until it encloses it like a sheath. The leaf-like organ resulting from the second cell of the lower pole of the embryo is at first, like the scutellum, independent of the apex of the stem, and morphologically equivalent to it. Neither can therefore accurately be termed a leaf. The first vascular bundle of the plant is formed at an early period by tangential walls in the eight cells which compose the centre of the embryo.

After fertilization the embryo turns, as in *Salvinia*, within the archegonium, so that the apex of the stem is turned towards that of the prothallium. The embryo breaks through the prothallium near the archegonium, and the prothallium then surrounds the foot of the embryo like a cup, carrying the withered archegonium on its dorsal side behind the scutellum.

To prepare for fertilization, the massulæ of the microsporangia, with their anchor-shaped glochidia, fix themselves in large numbers to the under epispore of the macrospores which are floating on the surface of the water. The central fibrous portion of the floating apparatus is perforated by a narrow canal, through which the antherozoids probably reach the archegonium. By their subsequent growth the prothallium, and later also the embryo, force themselves into this canal, and increase its size. By this means the three floating bodies are displaced from their original position, and finally stand at a right-angle from the macrospore. The indusium which covers the floating apparatus in the form of a brown cup is at the same time pushed upwards, and finally forced against the embryo. The hood-like fibrous layer which is closely applied to the floating apparatus, is turned over, and surrounds the foot of the embryo like a collar. Shortly afterwards the embryo detaches itself from the macrospore; the margins of the scutellum become broader, and then lie on the surface of the water in the form of cups or scales.

The strongly refractive bodies previously observed by others between the indusium and epispore, are, according to the author, *Nostoc*-cells, which find their way into the crevices between the scutellum and the young leaves when the apex of the embryo appears outside the epispore.

Development of the Sporangia and Spores of Isoetes.*—On the disputed point whether the sporangia of *Isoetes* spring from superficial or from deeper lying cells, E. Mer considers that he has demonstrated the latter from the case of sterile leaves which are the result of the abortion of the sporangia at various stages.

In the earliest stage of development of the sporangium, while the leaves are still in vernation, it is not connected with the leaf by a pedicel; the tissue is, on the contrary, homogeneous, composed of young, very delicate, polyhedral cells, with no trace of trabeculæ or envelope. The pedicel is afterwards formed by expansion of the lateral parts. The cells of which it is composed differ from those of the rest of the organ; they are elongated horizontally, are polyhedral, with very acute angles, and enclose starch. The macrosporangia and microsporangia can be distinguished even at this period. Among the cells of the macrosporangium appear radiating rows of cells, similar to those of the pedicel, which are the young trabeculæ; the external envelope becoming at the same time differentiated.

In the second stage the mother-cells of the macrospores increase in size, and contain vacuoles, growing at the expense of other cells which decrease in size and at length entirely disappear. The nutritive tissue is finally confined to one or two rows of cells situated at each side of the trabeculæ, which no longer contain starch.

In the third and final stage the mother-cells of the macrospores divide into tetrahedra; the macrospores become isolated, and float in the empty space between the trabeculæ. The mother-cells of the microspores cannot be made out till a later period than is the case with the macrospores.

In the primitive meristem, from which are developed the macro- and microsporangia, three tissues are speedily differentiated: viz. a formative tissue destined to produce the mother-cells; a nutritive nitrogenous tissue, which is absorbed at the expense of the mother-cells; and an amylaceous nutritive tissue intended to supply the mother-cells with nutriment.

M. Mer found that the supply of food-material caused a remarkable difference in the development of *Isoetes lacustris*, of which he accordingly distinguishes four forms. An abundant supply of food is necessary for the formation of the macrosporangia, an

* Bull. Soc. Bot. France, xxxviii. (1881) pp. 72–6, 109–13.

insufficient supply promoting the production of microsporangia. The dissemination of the macrospores extends over a longer period than that of the microspores. The bulbils correspond in this respect to the macrospores.

Muscineæ.

New Genera of Mosses.*—C. Müller describes four new genera of mosses:—*Wilsoniella*, belonging to Bryaceæ, one species from Ceylon, and another from Australia; *Thiemia*, belonging to Funariaceæ, one species from Burmah; *Rehmanniella*, belonging to Pottiaceæ, one species from South Africa; and *Hampeella*, belonging to Hookeriaceæ, one species from Java.

Classification of Sphagnaceæ.†—C. G. Limpricht lays considerable stress, in the determination of species of *Sphagnum*, on the relative position of the chlorophyllaceous and the hyaline cells in the leaves of the branches, a character which he considers has been too much neglected by Warnstoff in his recent synopsis of the group.‡ Limpricht reunites *S. subbicolor* Hampe and *S. glaucum* v. Klinggr. to *S. cymbifolium*.

Characeæ.

Cell-nucleus in Chara fœtida.§—F. Johow has made an extensive series of observations on the changes which take place in the nucleus in cell-division in *Chara fœtida*, for the purpose of determining the correctness on the one hand of Schmitz's description of it as "direct division of the nucleus," ‖ or that by Treub and Strasburger as "fragmentation." For this purpose he used chiefly the apical cells and primary segment-cells of the stem, those of the so-called "pro-embryo," of the leaves and cortical lobes, and of the nodes, employing the methods of hardening and colouring by means of picric acid and hæmatoxylin.

The results obtained were in many respects different from those previously described by Schmitz, Treub, and Strasburger, a difference which the author suggests may be explained by the fact that the various observers have had under observation different species or varieties of *Chara*. The "fragmentation" which Strasburger describes was also not observed by Johow in the staminal hairs of *Tradescantia*, the parenchymatous cells of *Nicotiana* and *Tropæolum*, or the suspensor of *Orobus*. The following are the chief points on which he insists.

The cell-nucleus of *Chara fœtida* retains the same structure in essential points throughout its existence, viz. a homogenous matrix in which are imbedded chromatin-particles of varying number and form; the occurrence of the nuclear wall is not limited to any particular stage. A disorganization of the cell-nucleus did not accom-

* Bot. Centralbl., vii. (1881) pp. 345–9.
† Ibid., pp. 311–19.
‡ See this Journal, i. (1881) p. 773.
§ Bot. Ztg., xxxix. (1881) pp. 729–43, 745–53 (1 pl.).
‖ See this Journal, i. (1881) p. 475.

pany or follow the fragmentation; on the contrary, the multiplication of the nuclei was accompanied by a considerable increase in size of the chromatin-particles and of the matrix. The same was the case with the cell-nucleus of Phanerogams. The division of the nucleus in the cell-division of *Chara fœtida* is completed in a manner very different from the later multiplication of nuclei, and presents also but little resemblance to the mode of division in most animals and plants. But in the older nuclei there is a considerable series of transitional forms in the same plant, to the most simple mode of division by means of external constriction of the nuclear mass without internal differentiation.

There appears to be no essential morphological distinction between karyokinetic division and fragmentation.

Fungi.

Conidial Apparatus in Hydnum.*—Ch. Richon describes what he considers to be a hitherto undetected reproductive apparatus in *Hydnum erinaceum*. It resembles that described by M. Cornu in *Ptychogaster albus*, and consists of intracellular conidia in the parenchyma, situated in the superior zone of the receptacle, and prolonged into the median zone. Instead of being produced at the extremity of cells of the parenchyma, they are formed and develope in the interior of the cells. They vary in size from 6–7 μ in diameter, being usually ovoid, less often rod-shaped. Conidia of somewhat similar origin are found in *Fistulina hepatica*, *Polyporus sulfureus*, and *Corticium dubium*.

Alternation of Generations in Uredineæ.†—E. Ráthay confirms Winter's observation that the *Cæomata*, on roses, potentillas, and the raspberry, are the æcidial forms of *Phragmidia*; he found spermogonia on them. The test of an æcidial form he considers to be not the envelope or the chain of spores, but the presence of spermogonia. He regards *Melampsora populina* and *Æcidium Clematidis* as probably developmental forms of the same species.

Mode of Parasitism of Puccinia Malvacearum.‡—The mode in which the germinating filaments from the sporidia of *Puccinia Malvacearum* penetrate the host has been variously stated to be through the stomata, and through the cuticle where the lateral join the superficial cell-walls. E. Ráthay finds that though the latter is often the case, they frequently perforate the epidermal cells at a point distant from any lateral wall.

Sterigmatocystis.§—Cramer first described this genus of fungi from *S. antacustica*, found in the ear of a deaf person. M. Bainier now gives the characters of six new species:—*S. usta*, *ochracea*,

* Bull. Soc. Bot. France, xxviii. (1881) pp. 179–82 (1 pl.).

† Verhandl. zool.-bot. Ges. Wien, Jan. 5, 1881. See Bot. Centralbl., vii. (1881) p. 164.

‡ Verhandl. zool.-bot. Ges. Wien, Dec. 1, 1880. See Bot. Centralbl., vii. (1881) p. 163.

§ Bull. Soc. Bot. France, xxviii. (1881) pp. 76–9.

quercina, *aerea*, *Helva*, and *fuliginosa*. They are found on all sorts of ternary compounds, starch, dextrine, sugar, paper, tannin, &c., and may be cultivated on gelatine, gluten, and bread, but not apparently on meat. They are extremely abundant on grapes, and on other edible commodities, the species being especially *S. nigra*, *carbonaria*, and *fuliginosa*, while *S. glauca* is found in wine. Glycerin is extremely prejudicial to their growth, and may be used to prevent their appearance. The spores have a great power of resistance to cold; and, when once established, these moulds are very difficult to extirpate.

Oospores of Phytophthora infestans.*—M. Cornu has reinvestigated the vexed question of the oospores of *Phytophthora* (*Peronospora*) *infestans*, which have not yet been recognized with certainty. The bodies described by W. G. Smith as the sexual spores of the *Phytophthora*, Cornu agrees with de Bary in regarding as in reality the oospores of a *Pythium*. Caspary and Berkeley, on the other hand, regarded as the true oospores of *Phytophthora* the bodies described by Montagne under the name *Artotrogus hydnosporus*, a conclusion doubted by de Bary on the ground of their alleged identity with similar bodies found on the turnip. Cornu shows, however, that this latter parasite is altogether different from that of the turnip. The bodies described as *Artotrogus* are of two kinds, one echinated, the other not. The former of these Cornu considers in all probability to be the oospores either of *Phytophthora*, or of some *Saprolegnia* at present unknown.

Peronospora viticola.†—E. Prillieux, after pointing out the known existence of conidia or summer-spores, and oospores or winter-spores, states that he has been able to convince himself, during the course of a mission undertaken under the instructions of the Minister of Agriculture, that there is no doubt as to the "prodigiously abundant formation of winter-spores" in various parts of France. The quantity of these small bodies which may be found in one dry leaf appears to be enormous (200 per square millimetre). Not much harm is done in dry weather, but when the seasons are wet the author thinks that all the vine-leaves should be collected and burnt.

Vegetation of Fungi in Oil.‡—P. Van Tieghem some years since observed the development of flakes of mycelium in a bottle of olive oil; this was due to two germs; one not cultivable on slices of potato, the other identified as very nearly allied to *Verticillium cinnabarinum*. Immersion of seeds or pieces of the higher plants, covered with mycelium growth, in the same medium, and placing in an atmosphere at about 25° C., produced after a few days a plentiful growth of mycelium over these bodies, on the surface of the oil, and at any points at which spores had been left in contact with the air. It is established that the oil is absolutely necessary to the life of the

* Bull. Soc. Bot. France, xxviii. (1881) pp. 102–9.
† Comptes Rendus, xciii. (1881) pp. 752–3.
‡ Bull. Soc. Bot. France, xxvii. (1880) p. 353.

fungus; it will not develope in linseed oil, colza oil, or water, and is killed if transferred from olive oil to any of these liquids. If the mycelium is removed from the plants before being transferred to the oil, its development is very slow, and fructification is not obtained; this is probably due to the want of the water which the plant contained. The systematic position of the form could not be determined.

He also finds as the result of subsequent investigations* that a number of mycelia flourish in a variety of oils, as those of olive, poppy, linseed, and colza, and in castor-oil. Most of these are still undetermined, and one appears to be a species of *Verticillium*. Among those which appeared in olive-oil is a new *Saccharomyces*, to which he gives the name *S. olei*. It consists of oval cells arranged in branched threads, which occasionally become broken up, and the isolated cells then bud and form new threads. The average size of the cells is $4 \cdot 0\ \mu$ by $2 \cdot 5\ \mu$; their contents of a pale or, in refracted light, of a slight rose colour. No disengagement of gas, or special odour, accompanies their growth. At length they form a farinaceous deposit at the bottom of the water. The nature of the oil is completely changed in the process, becoming white and milky in the course of about eight days. Neither *S. cerevisiæ* nor any other allied species will grow in olive-oil.

A moneron grown in the same way in castor-oil developed through the whole substance of the oil, rendering it opaline; it does not, however, change its nature or saponify.

If into any oil that has not been purified any body is introduced which has been soaked in water, the surface of the body is seen, after a few days, to be covered with an abundant vegetation, composed of the mycelia of a number of fungi, among which have been detected *Mucor spinosus* and *pleurocystis*, and species of *Verticillium*, *Chætomium*, and *Sterigmatocystis*, but most abundantly of all, *Penicillium glaucum*, which fructifies profusely, not only on the surface, as is the case with aqueous solutions, but throughout the oil. Other Ascomycetes produce not only their conidia, but also their perithecia in these conditions. These fungi are produced in a great variety of unpurified oils, but not in an oil which has been purified by sulphuric acid like colza-oil, or which has been strongly heated, like linseed-oil. If the moist substance is placed for a time in boiling water before its immersion in the oil, it still becomes covered after a time with the fungoid growth, showing that the spores are in the oil and not in the moist substance; the reason for their not developing in the oil, if left to itself, being that water is necessary for their growth. The plant obtains its necessary oxygen and nitrogen from the air dissolved in the oil; the oil itself furnishing direct to the plant the carbon and the hydrogen. A sufficient quantity of nitrogenous and mineral substances is always contained in unpurified oil. The oil remains perfectly limpid, and apparently does not undergo any change in composition, except a crystallization of fatty acids, indicating a slow saponification.

* Bull. Soc. Bot. France, xxviii. (1881) pp. 70–1, 137–42.

Parasitic Fungi.*—M. Cornu notices the occurrence of two parasitic fungi on hosts not previously observed, *Cylindrospora nivea* on *Veronica arvensis*, and a uredo, probably belonging to the cycle of generation of *Æcidium nitens*, on an unnamed American *Rubus*.

Ear-Fungi.†—Fr. Betzold has detected the following species of Hyphomycetes as accompaniments of diseases of the ear, viz. *Aspergillus nigricans*, *flavescens*, and *fumigatus*, and *Trichothecium roseum*. He does not regard these fungi as saprophytes, but as the actual cause of inflammation.

Insect-destroying Cryptogam.‡—J. Lichtenstein calls attention to a very curious case of parasitism, namely, the presence in the hot-houses of the Jardin des Plantes, at Montpellier, of an "insecticide cryptogam" (a *Botrytis*), which killed all the aphides on a *Cineraria*.

The action of the parasite would appear to cease in the open air, at least the author was unable to inoculate with it either the *Phylloxera* or an Aphis (*Chaitophorus aceris*). Perhaps, the author speculates, direct inoculation is impracticable, and there may exist an intermediate stage on other creatures, as in *Entomophthora* and other Cryptogams.

Brefeld's Schimmelpilze.§—The fourth part of O. Brefeld's general work on mycology treats of the moulds or Schimmelpilze, and is introduced by some general remarks on the cultivation of microscopic fungi. He especially recommends the use of Geissler's modification of Recklinghausen's chamber, which has special advantages for the culture of single specimens.

The life-history of *Bacillus subtilis* is described in detail, followed by that of *Chætocladium Fresenianum*, parasitic upon *Mucor* and *Rhizopus*, but which will readily grow in nutrient fluids, and can easily be made to produce zygospores. Two new species of *Thamnidium*, and one of *Mucor*, are also described. He regards as the ancestor of the Zygomycetes a form with one kind of sporangium, from which sprang the Thamnidieæ with sporangia and sporangioles. Thence were derived various branches:—by the reversion of the sporangioles to forms with single conidia; by the separation of the sporangioles and conidia to separate receptacles, to the Choanephoreæ; by the abortion of the sporangia to the Chætocladiaceæ.

Under the head of *Pilobolus*, a special description is given of *P. anomalus*, in which large portions of the mycelium, divided off by septa, produce each a receptacle; a division in the young sporangium after the formation of the columella leads to the production of the sporiferous portion and the swelling-layer, which, after first becoming dry, then absorbs water, swells up, and separates the sporangium from the pedicel. The author has, in this species, observed germinating

* Bull. Soc. Bot. France, xxviii. (1881) pp. 143–6.

† 'Zur Aetiologie der Infectionskrankheiten,' 1880, pp. 95–109.

‡ Comptes Rendus, xciii. (1881).

§ Brefeld, O., 'Unters. aus dem Gesammtgebiet der Mykologie. Heft 4. Bot. Unters. über Schimmelpilze.' 191 pp. (10 pls.). Leipzig, 1881.

zygospores in the ordinary receptacles. Very different is the origin of the receptacle in five other species of *Pilobolus*, in which only a single short tuberous piece is divided off from the mycelium by a septum, the receptacle being produced entirely in this. The energy of the process by which the spores are thrown out is in inverse proportion to the length of the pedicel. The author was unable to find zygospores in these species, and believes the sexual mode of reproduction to have fallen, with them, partially into abeyance. The production of the receptacle of *Pilobolus* is greatly dependent on light.

Descriptions follow of other Zygomycetes, *Sporodinia grandis* and *Mortierella Rostafinskii*, the latter of which is found on horse-dung. The short mucor-like receptacles are formed on short stolons, and are usually fixed to the substratum by thick bundles of rhizoids at the base of the receptacle, often enveloping it, and thus forming a tissue composed of unseptated filaments, resembling a capsule, and about one-fourth the height of the receptacle, the sporangium being exserted from its apex. The outer portions of this structure are of a yellowish or brownish colour, and are cuticularized, the sporangia remaining white even when mature. The sporangia are not produced from the entire apex of the fertile hyphæ, but only from a small central zone, a peculiar constriction being formed beneath them. When the spores have been formed out of the protoplasm, a division-wall separates the sporangium from the pedicel without the formation of a columella. As the spores are developing, the walls of the upper part of the pedicel become thicker, as also does the basal part of the wall of the sporangium, which remains behind like a collar when the upper part has become separated and the spores have escaped. In old cultures, or those which have been disturbed, gemmæ often made their appearance, as in *Mucor racemosus*. In very poor nutrient fluids, the number of spores was reduced from many thousands to two or four, and the rhizoids were entirely wanting. After long-continued culture, and the succession of from ten to twelve generations, the production of non-sexual receptacles almost entirely ceased, and zygospores only were produced, enclosed in large brown capsular tissues. In other instances, however, this envelope was wanting.

The nature of the sporangium and the conidia derived from it are used by Brefeld as the foundation of the classification of the Zygomycetes, which he divides into five families, viz. Mucorineæ, Thamnidieæ, Choanephoreæ, Chætocladiaceæ, and Piptocephalideæ.

In *Entomophthora radicans*, Brefeld describes the formation of the resting-spores, from which he concludes that the Entomophthoreæ form a small family more nearly allied to the Ustilagineæ than to the Peronosporeæ, being most nearly connected with the former through *Entyloma*. In both families he considers the resting-spores to be oogonia, in which the formation of spores is suppressed, and the oogonium itself has become a spore. Their natural position is therefore in the Oomycetes, near to the Phycomycetes. Two new species of *Empusa* are described, one parasitic on flies, the other on gnats.

The formation of both conidia and sclerotia is followed out with care in *Peziza tuberosa* and *sclerotiorum*, and the view is confirmed that there is no causal connection between the two. The sclerotia always proceed from a mass of hyphæ which put out abundance of shoots, and are more slender than other mycelial filaments. As soon as they begin to coil and interweave, a general lateral branching takes place, which gradually fills up all the air-cavities in the ball, and unites the hyphæ with one another. The sclerotia retain their power of germination for years, if kept dry. They then put out thick greyish-yellow club-shaped bodies composed of nothing but hyphæ, which grow by apical growth and finally become the fertile cups, the apical growth ceasing at the middle, while the peripheral filaments continue to grow and branch abundantly. After growth in length has ceased, a layer of paraphyses is formed gradually from the middle towards the margin, the asci being then formed, their formation continuing after the expulsion of the first spores. The ascospores, eight of which are contained in each ascus, are 8 μ broad and 12 μ long. They germinate at once, and form ordinary mycelia with sclerotia. In the autumn the club-shaped bodies often form secondary clubs, even to several generations, which produce cups in the next spring. If the clubs are covered with a small quantity of earth, they produce much-branched strings of Rhizomorpha, on which new clubs appear at all points. In certain circumstances the branches of the paraphyses develope into receptacles with conidia ; they often make their appearance in the cups as forerunners of the ascogenous layer.

On the sclerotia of these two species of *Peziza* there often appears a pycnidial form which interferes with the formation of the cups. Cultivation produced no other form of this fungus, which Brefeld calls *Pycnis sclerotivora*. The germination and formation of the mycelium and abstriction of the spores are described in detail.

With regard to other Ascomycetes, he finds the processes similar in all essential points in *Peziza cibarioides*, *Fuckeliana*, *coccinea*, and *aurantia*, *Otidea leporina*, *Sarcosphœra macrocalyx*, *Leotia lubrica*, *Geoglossum*, *Morchella*, and *Helvella*; except that in the last two genera no conidia were observed, and in *Peziza Fuckeliana* the attempt was unsuccessful to obtain from the *Botrytis*-spores perfect sclerotia which developed into cups. All the above-named agree in this point, that the differentiation of the hyphæ into sterile and fertile takes place only when the receptacle has nearly reached maturity. In other forms, as *Ascobolus denudatus*, *Erysiphe*, *Eurotium*, *Penicillium*, *Melanospora*, and *Xylaria*, this differentiation takes place at a very early period. In the first of these, after several generations, large masses of thallus arose out of scolecites. In some instances the formation of conidiophores precedes or accompanies that of the receptacles; but they may be altogether wanting. Brefeld considers the so-called "pollinodia" to have no other function but that of enveloping tubes; the conidia and receptacles are therefore of non-sexual origin.

In three small Ascomycetes grown on hare's dung, one of which resembled *Ryparobius myriosporus*, the formation of the asci could be traced back to a single cell or ascogenous filament, as also was the case in *Melanospora*, the perithecial form of *Botrytis Bassiana*.

As regards the general structure and position of the Ascomycetes, Brefeld regards the three following as the most important points:—1. The degradation of the various forms of fructification; 2. The disappearance of sexuality, either from the forms of fructification or with them; 3. The reversion of sporangia to conidia. All known fungi he divides into the two great divisions of Phycomycetes and Mycomycetes. To the Phycomycetes belong two classes, viz.:—1. Zygomycetes (Mucorineæ, Thamnidieæ, Choanephoreæ, Chætocladiaceæ, and Piptocephalideæ); and 2. Oomycetes (Chytridiaceæ, Saprolegnieæ, Peronosporeæ, Entomophthoreæ, and Ustilagineæ). The Mycomycetes are composed of three classes, viz.:—3. Ascomycetes; 4. Æcidiomycetes; and 5. Basidiomycetes. The lowest forms of fungi he regards as nearly related diverging branches from a common origin. The same is the case also with the higher forms. In both higher and lower forms he finds the same tendency for the sporangia to revert to the condition of simple conidia, and for the fructification to lose its sexuality.

The multinucleated condition of the cells of many unicellular Thallophytes Brefeld regards as an indication that they are descended from multicellular forms from which the cell-walls have disappeared. The family in which this degradation has been carried to the greatest extent is the Myxomycetes, constituting a third great division of the Fungi, in which the cell-walls even of the spores have disappeared, the vegetative life being carried on by permanently naked cells.

Both the higher and lower Fungi may be traced back to a sporangiferous parent-form, probably green and belonging to the Algæ, in which there was already a differentiation into sexual and non-sexual forms of fructification. Sexuality was therefore the original condition of all Fungi, but has in many cases disappeared, a phenomenon not seen elsewhere in the vegetable kingdom. All three forms of fructification, or only some, or none, may have degenerated to the condition of conidia. Hence we may get forms with only male, others with only female organs. The number of forms of fructification may also be increased beyond three, as in the Æcidiomycetes. There may also be in addition a pure vegetative mode of increase, by the breaking up of the mycelium, or the separation of shoots. In these cases all other modes of reproduction, all kinds of fructification, may disappear, and propagation take place in a vegetative way only.

The pollinodia of the Ascomycetes not having the male character assigned to them by de Bary, Brefeld regards the ascocarp as an originally female mode of fructification which has lost its sexual character; the spermatia indicating, in their inability to germinate, their original male character. The conidia are the result of degradation of the asci. In the Erysipheæ, Pyrenomycetes, and Discomycetes, the apothecia or perithecia may, from analogy, be regarded as similar degraded female organs; in the ascophores of *Exoascus* and *Taphrina* both sexual and non-sexual forms of fructification occur.

If the ascus is to be regarded as a sporangium, and the conidia as degraded asci, it is clear that no great stress should be laid, from a systematic point of view, on the higher differentiation of the fructification, its development into a carpospore, &c. A relationship of the Ascomycetes may then be traced downwards with the Phycomycetes, upwards with the Æcidiomycetes and Basidiomycetes. In the ascus or sporangium is the point of connection with the lower Fungi, in the conidia or degraded sporangia that with the higher Fungi; while the sporangium further indicates the descent of all the Fungi from Algæ.

Influence of Light on the Growth of Penicillium.*—In his experiments on the growth of Fungi in oil,† P. Van Tieghem observed that the development of *Penicillium glaucum* is powerfully affected by light. It is only in the spots that are strongly illuminated that the mycelium developes into a continuous coating, very little or none appearing on those that remain dark.

Production of Microphytes within the Egg.‡—G. Cattaneo has lately occupied himself with the solution of the question whether the fungi which so frequently develope within bird's eggs are introduced into the egg from without or whether, as is held by a number of Italian investigators to be the case with regard to the Schizomycetes, they may arise independently within the egg, out of its own constituent elements. A preliminary consideration of the ways by which the spores might enter the egg while still in the body—namely, by the lungs and air-sacs, by the alimentary canal, and finally by the cloaca and oviducts—leads the author to the conclusion that it is most unlikely that the spores should enter the developing egg by these routes. Thus the development of fungi in eggs shortly after they are laid is probably not to be referred to spores introduced from without, even though the fungi should sometimes enter through the egg-shell. His own observations on the development of fungi within and upon eggs, which were carried on in a moist chamber, in part upon eggs covered with a coat of wax or copal varnish, led to the result that the growths of *Penicillium*, *Aspergillus*, &c., which often develope in such abundance on eggs thus treated, seldom pass into the interior, and have not the power of penetrating the skin of the shell; and that, on the other hand, the growths of *Leptothrix* and *Leptomitus* which spring up only in eggs which have not become decomposed, are produced on the inner side of the skin of the shell, and manifest centrifugal growth outwards through the pore-canals of the egg-shell, without showing any indication of an entrance from outside.

Ætiology of Diphtheria.§—Oertel believes the contagium of diphtheria to be an excessively minute organism, to which he gives the name *Micrococcus diphtheriæ*. It has an oval form, with a length of

* Bull. Soc. Bot. France, xxviii. (1881) p. 186.

† See *ante*, p. 81.

‡ Atti Soc. Ital. Sci. Nat., xx. (1 pl.). Cf. Zool. Jahresber. Naples, i. (for 1879) p. 123.

§ 'Zur Aetiologie der Infectionskrankheiten' (1881) pp. 199-246. See Bot. Centralbl., vii. (1881) p. 269.

1–1·5 μ, and a breadth of 0·3 μ; larger individuals, found nearer the surface, being 4·2 μ long and 1·1 μ broad. Where the individuals are more scattered, they occur mostly in pairs, rarely a number connected into a torula-like chain. When present in masses the cells lie so close together that it is difficult to determine whether they are connected or not. They are then imbedded in a gelatinous envelope, and thus combined in masses into a colony. Addition of acetic acid makes the mass clearer, so that the combination in pairs and the more rod-like form of the separate cells is more readily seen. These organisms penetrate the epithelium. They are found chiefly in the mouth and throat; and may be conveyed through the air, by direct contact, through the saliva, or by contact with a great variety of objects, as plates or drinking glasses, clothes, toys, linen, &c. The most favourable nidus for their development and fatal activity is when, from injury to the cuticle, they come into direct contact with the blood and tissues.

The author believes the micrococcus to be specifically distinct from those which produce other infectious diseases. The apparent spontaneous production in some cases of diphtherial disease may arise from the germs being present in some other organism in a different form, in which it is incapable of producing disease, or from its being present in the infected subject in a latent condition, waiting favourable conditions for its development. The average length of time through which the disease runs before reaching its culmination may be stated as from two to five days.

Properties and Functions of Bacteria.*—Prof. J. B. Schnetzler finds that Bacteria, as well as Infusoria of the genus *Vorticella*, live and exhibit activity in a solution of curare; moreover the muscles and cilia of the Turbellarian *Planaria torva* and some of the muscles of *Gammarus pulex* were found to act with energy after being exposed to the same reagent for twenty-four hours. But *Bacillus subtilis* is killed immediately by perchloride of iron solution. The bacteria produced during decomposition of a plant do not produce fatal results when injected into the vessels of a rabbit. Prof. Schnetzler shows that a highly organized plant may be watered exclusively by a fetid liquid full of bacteria, without undergoing fermentation or decomposition of its parts; the bacteria (*Micrococcus* and *Bacillus*) may be found in the leaves, but they also occur in those of plants which have been watered with ordinary water.

Finding bacteria in the condensed moisture which appears on the cover of a vessel containing bacteria and green algæ, Prof. Schnetzler explains their appearance there by the bursting of the bubbles of oxygen which rise to the surface under the influence of sunlight and in bursting scatter the bacteria which they have brought up with them.

Atmospheric Bacteria.†—Continuing his previous investigations, on this subject,‡ P. Miquel gives the averages since obtained by him,

* Bull. Soc. Vaudoise Sci. Nat., xvii. (1881) pp. 625–32.
† Bull. Soc. Bot. France, xxviii. (1881); Rev Bibl., p. 11.
‡ See this Journal, iii. (1880) p. 837.

showing for each month the quantity of spores in the air of Montsouris, and describes some interesting facts concerning the cultivation of bacteria.

Bacillus ureæ, cultivated in neutral bouillon, falls to the bottom of the vessel, and dies, leaving the liquid perfectly transparent; but if a little pure urea is added when the parasite is living, the fluid becomes cloudy and charged with carbonate of ammonia. Of all the species cultivated by the author in a state of purity, none abandoned their special aptitudes nor departed from the cycle of evolution proper to each. Certain illusions and analogies are therefore to be guarded against. *Bacilli*, in the absence of oxygen, can assume a resemblance to *Bacteria*, and *Bacteria* when dead are easily confounded with *Micrococci*.

Pathogenous Bacillus in Drinking Water.*—J. Brautlecht has detected in drinking water, which was considered to be the partial cause of an epidemic of typhus, a bacillus which he cultivated in a solution of 3 per mil. gelatine in spring water, with 25 per cent. ammonium phosphate. This was distinguished from other non-pathogenous bacilli by the absence of any powerful reducing action and also of the offensive odour of some other species; having a pleasant odour somewhat like that of boiled milk. This bacillus forms filaments in the nutrient fluid, which soon break up into short rods, which separate into cocci loosely connected in a moniliform manner. In later cultures only rods and cocci were visible, which did not exhibit any spontaneous motion. Besides the suspected drinking water, a bacillus with the same characteristics was found in the urine of typhus patients, also on the surface of thick masses of putrefying algæ. When inserted beneath the skin of a rabbit, these bacilli caused violent fever in from 18 to 36 hours.

Connection of Diseases with specific Bacilli.†—H. Buchner describes a series of experiments for the purpose of determining whether contagious diseases are caused entirely by the bacilli which are found to accompany them, or whether the action of these is assisted by a peculiar chemical substance resulting from the diseased tissue. The results pointed entirely in the direction of the first of these hypotheses. It was found in the first place that the cattle disease was produced by bacilli originally taken from diseased subjects, even when these had been cultivated to thirty-six generations, when it was impossible for the least trace of any disease-producing substance to exist which had come directly from the diseased subject. In the second place, it was found, after repeated and long-continued culture, that these disease-producing bacilli differed in no visible respect from the bacilli produced spontaneously in hay; while with the latter he was able to produce the disease by injecting it into the blood of white mice and rabbits.

* Virchow's Arch. path. Anat., lxxxiv. p. 80. See Naturforscher, xiv. (1881) p. 320.

† 'Zur Aetiologie der Infectionskrankheiten,' 1881, pp. 69–94. See Bot. Centralbl., vii. (1881) p. 237.

Origin of the lowest Organisms.*—F. Krasan, in an extraordinary production published in the Transactions of a learned Society as a serious paper, discusses the hypothesis of a possible archibiosis in the case of the lowest organisms, and supports his opinion in favour of this mode of origin in at any rate a spirited manner by the results of a series of experiments. He does not contest the argument that many of the lowest forms arise from such germs as may be contained in dust, but insists that the proof of such an origin is much hindered by the mechanical difficulties of manipulation. The experiments are divided into three series:—

1. Relations of *Bacteria* to certain microscopic structures contained in the seeds of many plants, and the action of phosphate of hydrogen, soda, and ammonia (microcosmic salt) and atmospheric dust:—

The close connection alleged to exist between bacterian movements and the molecular movements of organic particles is illustrated by the phenomena exhibited by drops of oil derived from seeds, such as those of the parsnep and of melons and gourds, also hazel-nut kernels, broken up in water (either distilled, stream, or spring water). These drops are of different sizes, and generally contain vacuoles filled with water, coloured pale red, and each surrounded by a bluish-green halo, the whole mass being greenish-grey or pale green; they consist of a mixture of oil, albumen, and a carbohydrate. If one of the superficial vacuoles is closely examined, it is seen to contain an immense number of very minute roundish bodies in rapid movement of a swarming character. The vacuole increases in size by pushing its way to the exterior, where it finally bursts, discharging its contents into the surrounding water; a small portion remains, and is enclosed by the collapsed oil-globule. The minute bodies thus liberated move towards the edge of the cover-glass, and at the same time approach each other in pairs, and after rotating very rapidly become quiescent and unite, forming cylindrical masses. These are considered by the writer to be half-formed bacteria, and they are said to be almost identical in appearance with true bacteria, but differ in possessing the property of dichroism, which becomes more marked towards the edge of the glass, and is probably, together with the phenomena of conjunction, connected with the proximity of the air. These bodies may be dried, and yet resume their characters when again moistened.

The following differential experiments were undertaken. To equal parts of a $5\frac{1}{2}$ to 6 per cent. solution of sugar in distilled water was added a rather smaller proportion of gypsum or freshly burned coal-ash (rich in sulphate of lime); to one-half of the mixture was added 20–40 milligrams of atmospheric dust, to the other half 4–8 milligrams of the phosphate salt; both were stirred, covered, and set aside in a temperature of 10°–14° C. In 48 hours the dust-containing mixture contained isolated bacteria in active movement, while the other showed quantities of them, forming groups on the air-bubbles; thus a small amount of the phosphate salt was more pro-

* Verh. zool.-bot. Ges. Wien, xxx. (1881) pp. 267–327 (1 pl.).

ductive of bacteria than five times its proportion of atmospheric dust; in the latter case the forms are chiefly *Bacterium lineola*, in the former *B. termo;* this difference bespeaks a different origin for the two growths.

Solution of sugar and the microcosmic salt and coal-ashes in distilled water produced no bacteria in 28 hours after addition of dust, and but few when left to itself, but with a drop of bacterian liquid it contained abundance, arranged in tracts; in 45½ hours the condition was essentially the same, but after 68 hours the dust preparation contained an abundance in masses; also the uninfected solution, but here development appears to have begun four or five hours later than in the dust preparation.

Pieces of an almond more than two years old were boiled for a minute in distilled water, and the decoction put while hot into 9 watch-glasses, "cleaned, as usual, as well as possible," and covered up. The contents of these glasses were variously treated, with the following results:—

No. 1. Left untouched; developed a yeast-fungus and some mycelia, after the lapse of 22 days.

No. 2. Similarly treated; was filled with mould and fermentation fungi after 13 days.

Nos. 3, 4, and 5, having received, the one 2 grams, the other a drop of distilled water, the third a drop of emulsion of almond kernel in distilled water, were clouded with a minute bacterium in 48 hours.

No. 6 received two pieces of almond, and began to be clouded with a bacillus in 70 hours.

No. 7, infected from an emulsion full of bacteria, swarmed with the same form in 24 hours.

No. 8, which had received a few milligrams of atmospheric dust, showed some larger bacteria, some being united into rods and chains, after 44 hours.

No. 9 was infected with a dried-up drop of bacterium liquid, and became cloudy in 40 hours.

From these and similar experiments Krasan concludes, first, that heat disorganizes the molecules of organic substances so as to render them incapable of becoming rearranged into organic structures without the stimulus of fresh air or other agents; secondly, this stimulus need not proceed directly from organic germs strictly so called, but may just as well be derived from the fresh air itself. Water and various liquid and solid organic substances are employed, which are either unaltered by heat, or else have been long in contact with fresh air.

Krasan considers the possible inorganic origin of low organisms absolutely proved by his finding them developed first in the *Micrococcus*-, then the *Zooglœa*-form in a precipitate of calcium phosphate in calcium sulphate solution to which sugar had been added; he has observed them to arise from minute granules which occur in the freshly formed precipitate, and considers it due to decomposition of the sugar molecules and recombination of their radicals with the other constituents.

2. *Development of Monads.*—Under this term are here included only low organisms of the form of swarm-spores, about 4 micro-millimetres in diameter. These become very slow in their movements, and proceed to reproduce by fission in very concentrated emulsions, but when transplanted to a dilute liquid become very active, and exhibit the peculiarity of attracting particles of various sizes and expelling them again with vigour, a process set down to an electric energy, residing in its greatest power at the base of the flagellum. Investigations extending over two years failed in discovering another mode of increase but that by fission. Repeated experiments, however, of which the object—viz. that of discovering a method of genesis which dispenses with any antecedent organism—is not concealed, were, so the author relates, at length rewarded. Some " aleuron-granules " from hazel-nut kernels mashed-up in water, were observed to resolve themselves into granular jelly-masses of globular form; from this mass the monad is said to develope, or several may arise from a single mass. A large monad with a proboscis was seen to arise from an aleuron-granule by fission of its substance and extension of the gelatinous material at two opposite points, forming a fusiform body; if the formative mass is larger than the normal monad it divides and forms two. Oily drops of protoplasm also become converted into monads. The production of these organisms is dependent on the time during which the seed has been left to dry in its shell. Monads were also produced from a mixture of sugar and stream or spring water and a phosphate, by contraction or fission of the flocculent precipitate contained in it. Two sizes of monads are produced from a solution of Umbelliferous seeds in spring water; the larger are derived from the smaller. Ciliated Infusoria are said to have been seen to develope from zooglœa-masses; the process occurs in the early morning, between 1 and 4 A.M. (!) *Leucophrys* is generated with especial ease from water, sugar, and a phosphate. Thundery evenings in August and September are the best times for such developments to occur; monads and ciliated Infusoria are mutually exclusive, and do not develop from the same solution.

3. *Effects of Contact* are the subject of the third and last series of investigations. Krasan finds that the development of bacillus in infusions of seeds in boiling water is almost entirely dependent on the retention in the fluid of the solid bodies used to make the infusion; but that the presence of all kinds of solid bodies in infusions of other kinds considerably facilitates and is indispensable to their development; the result of this is thus stated. (1) Solid particles and heterogeneous bodies in a solution of formative organic substances exercise a favourable influence on the process of formation by their presence, and being in contact with the solution, inasmuch as they accelerate the interchange of matter, and give a definite direction to the organizing activity of the molecular forces. (2) The nature of the foreign bodies is not without influence on the size, form, consistence, colour, and mobility of the organisms which are produced.

The author invokes the action of physico-chemical forces in aid of his theory, and explains the phenomena on which he based it; chiefly appealing to the different electrical polarities of the substances employed—a line of argument familiar to most of those who have studied the question of the origin of life.

It is to be observed, in estimating the scientific value of these experiments, that the highest magnifying power mentioned as being employed is 610 diameters, and that as a rule no special attention appears to be given to the cleaning of the vessels, or the sterilizing of the air or water, the latter being as often ordinary spring- or stream-water as distilled. The value of the reasoning is still further impaired by the fact that the latest experiments which have been adduced in opposition to the ancient theory here advocated afresh are dismissed without much consideration, even those of Tyndall receiving but scanty attention.

Prolongation of Vegetative Activity of Chlorophyllian Cells under the influence of a parasite.*—According to the Schwendenerian theory lichens are complex organisms, consisting of an alga, and a fungus which is parasitic on it. It seems extraordinary that the alga, thus embraced by a parasite, not only continues to live, but increases and multiplies, and is apparently endowed with new vigour. The same alga, alone, becomes discoloured and disappears on the return of the dry season; but in the lichen state it often persists for years. It has been said by Rees, that there are no other such cases known of vegetative activity being prolonged under the influence of a parasite; but Max Cornu has lately called attention to several. Thus, maples are often attacked, late in summer, by an *Erysiphus* which occupies the under surface of the leaves. The parts thus occupied remain green when the rest of the leaf has withered, and even after the leaf has fallen. Similarly with a parasite which attacks leaves and fruits of pears, apples, &c.; indeed, the fact is very general; the chlorophyll-cells attacked retain their green and their vital activity longer than the others. The phenomenon is explained by the fungus counter-balancing the return of nutritive matters towards the reserve centres. Green algæ have a vegetative period, during which they retain this colour very intensely; then they grow yellow and form durable spores, after which the vegetative part dies. In lichens the fungus prevents this development of spores, and so favours the life of the alga. Flowering annuals similarly may be preserved many years by prevention of flowering.

Algæ.

Classification of Nostoc.—In the second fasciculus of MM. Bornet and Thuret's 'Notes algologiques,' M. Bornet gives a full life-history of the genus *Nostoc*, including the germination of the spores and the development of the hormogonia, which display motility after their escape. The thickening of the filaments takes place in many species, without having any specific value. With *Nostoc* M. Bornet

* Comptes Rendus, xciii. (1881). See also Mr. P. Geddes' recent researches on "Animal Lichens," 'Nature,' xxv. (1882) pp. 303–5.

unites *Monormia* Berk. and *Hormosiphon* Kg., and distinguishes the following groups and species.

1. *Intricata.* Aquatic, softly gelatinous, without definite form, often floating:—*N. Hederulæ* Men., *tenuissimum* Rbh., *Linkia* Roth., *intricatum* Men., *crispulum* Rbh., *piscinale* Kg., *carneum* Ag., *rivulare* Kg.

2. *Gelatinosa.* Fixed; soft and gelatinous. Cells of the young filament elongated cylindrical. Spores large, elongated:—*N. spongiæforme* Ag., *gelatinosum* Shousboe, *ellipsosporum* Rbh.

3. *Humifusa.* Terrestrial. At first globular, afterwards coalescent and gelatinous, forming coatings adherent to the substratum. Spores smooth:—*N. collinum* Kg., *muscorum* Ag. var. *tenax* Thur., *Passerinianum* De Not., *humifusum* Carm., *calcicola* Bréb., *foliaceum* Morg.

4. *Communia.* Terrestrial, occasionally aquatic. At first globular, subsequently tongue-shaped, flat and irregular, not attached to the substratum:—*N. cimiflorum* Tourn. (*commune* Vauch.).

5. *Sphærica.* Globular, or often irregularly round when they grow larger. Surface firm and resistent:—*N. sphæricum* Vauch., *rupestre* Kg., *macrosporum* Men., *sphæroides* Kg., *cæruleum* Lyngb., *minutissimum* Kg., *gregarium* Thur., *edule* Mont., and Berk., *pruniforme* Ag.

6. *Verrucosa.* Aquatic; rounded or disk-shaped, at first solid, then hollow, protected by a firm tough membrane. Filaments delicate, distant, and somewhat curved in the middle, crowded and much bent at the ends:—*N. verrucosum* Vauch., *parmelioides* Kg.

7. *Zetterstedtiana.* Aquatic; globular, hard, warty, divides readily into separable segments:—*N. Zetterstedtianum* Aresch.

8. *Flagelliformia.* Terrestrial; narrow, linear, forming dichotomously divided bands:—*N. flagelliforme* Berk.

Diatoms of Thames Mud.*—Dr. F. Bossey has investigated the fresh- and salt-water diatoms found in mud-banks in the Thames, for the purpose of showing the influence of the flood and ebb tides on their formation, and gives the details of the result in an elaborate table.

Mud taken from seven different localities showed the following proportions of fresh-water and salt forms:—

	Fresh water.	Salt.
Half a mile above Teddington Lock	66	0
One mile below Teddington Lock ..	54	0
Kew	52	37
Blackwall	39	45
Estuary of the Thames	9	60

Dr. Bossey considers that in face of these facts the study of the natural history of the Thames mud affords important evidence in support of the position taken up by the Conservators of the Thames, that the mud-banks forming in the river owe their origin to the discharge of matters from the outlets of the main-drainage system.

* Proc. Holmesdale Nat. Hist. Club, 2 pp. and a table.

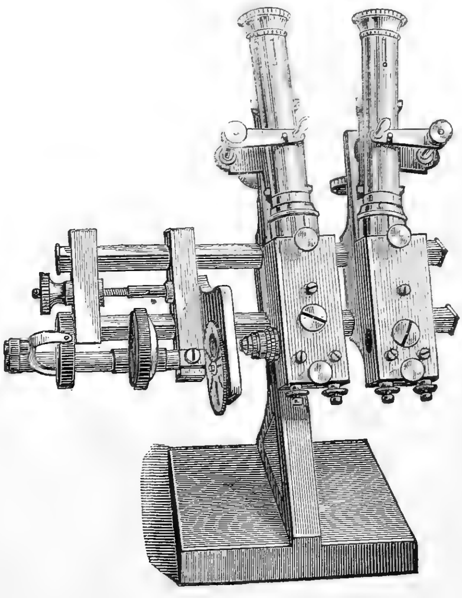
MICROSCOPY.

a. Instruments, Accessories, &c.*

Goltzsch's Binocular Microscope.†—We give the description of this Microscope, translated from the author's German original, with slight modifications only.

"This Microscope (Fig. 3), which is simple to the highest imaginable degree, is calculated to obviate a number of theoretical and practical objections which may be raised against instruments of the same kind hitherto described. In particular we get rid of—

FIG. 3.



(1) All difficulty in combining the images and all strain to the eyes.

(2) All variation in magnitude and distinctness, as also in the adjustment of the images.

(3) All difficulty in accommodating the instrument for different widths between the eyes.

(4) The influence which the thickness of the glass prisms, analogous to the known influence of the thickness of the covering glass, might exert on the course of the rays.

And lastly, instead of the double reflection, which is not avoided in any of the instruments known, there is only a single reflection for each half of the rays.‡

All these advantages are obtained by a slight modification in the manner in which the images are produced. Whilst in the case of the compound Microscope the object must always be a little beyond the focal point, and in the simple Microscope is generally nearer, in the new arrangement it is brought to the focus itself, so that the pencils of rays proceeding from the different points of the object,

* In this section are also included optical notes, notices of books relating to the Microscope, and miscellaneous microscopical notes.

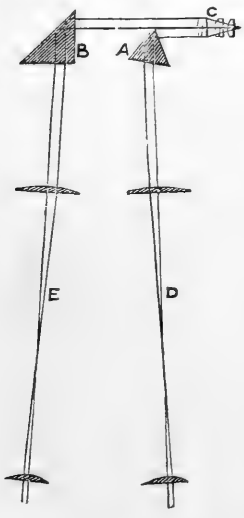
† Carl's Repert. f. Exper.-Physik, 1879, pp. 653–6 (1 fig.). Zeitschr. f. Mikr., ii. (1879) p. 166–9.

‡ The author appears not to have seen the Stephenson binocular.

although their inclination to the axis is different, leave the objective as pencils of parallel rays, and therefore of themselves produce no image, or rather one at an infinite distance. The convergence of the pencils of rays requisite to produce a real image is effected afterwards by means of the eye-pieces, which consequently it would be more correct to regard as telescopes, though they consist, like ordinary microscopical eye-pieces, only of two plano-convex lenses of crown glass, the ratio between their focal lengths being about 1 : 3. It will be seen at once that, by employing this telescopic eye-piece to receive the pencils of rays emerging parallel from the objective and coming as it were from an infinite distance, it is not necessary that Microscopes thus constructed should be of a fixed length. The length may be altered at will without producing any change in the amplification and distinctness of the image after it has been once obtained, provided the telescopic eye-piece is so adjusted, by means of a draw-tube arrangement, that distant objects can be clearly seen by it. It is equally obvious how, by this process, the exact parallelism of the pencils of rays emerging from the objective, and consequently the position of the object in the focus, is regulated and known. This furnishes us with a basis which renders it possible to obtain such a direction for each half of the pencil of rays by a single reflection that each eye can take in one of the halves.

In the original axis of the Microscope there are placed two glass prisms, a smaller, A, Fig. 4, and a larger one B, which are fixed in such a manner that the smaller prism causes one half of the rays and the larger prism the other half to be diverted from the axis under different angles by total reflection. The two pencils D E of parallel rays, are directed into the eye-pieces through two tubes which converge slightly towards the lower extremity. The original axis of the Microscope lies horizontally, and on the right of the observer is the objective C, the stage, and the illuminating apparatus; the observer looks down from above (in a direction inclined as may be desired) through the two converging tubes, directly upon the horizontal axis and with each eye over one of the two reflecting prisms. The first of these of course projects only as far as the axis, so as to leave half the opening free for the second. They are so arranged on the axis that they, with the eye-pieces to which they are attached, can be moved by rack and pinion so that their distance apart corresponds with the distance between the eyes of the observer, without the image being affected by the difference or alteration in the course traversed by the pencils

FIG. 4.

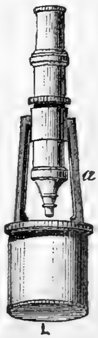


up to the first lens of the eye-piece, their rays being parallel. To this parallelism it is due likewise that every disturbing effect (like that which the thickness of the cover-glass exerts) by the prisms on the transmitted pencil is excluded, for such effects can only be produced by converging or diverging pencils.

The mode of using an instrument so constructed does not differ from that of an ordinary Microscope, except that first the two eye-pieces must be removed and adjusted for infinite distance, and then replaced. By means of the adjusting movement the left eye-piece tube is then put in such a position that with proper illumination the two diaphragm apertures of equal size, which are inside the eye-pieces, are seen without effort as one; an object being now introduced and brought into focus, the plastic image infallibly appears, and cannot be seen double. To produce this effect in perfection, however, the position of the prisms must be so adjusted that the images together with the diaphragm apertures become merged into one complete whole, and the impression is produced of looking through a round opening at the object which is behind. After this position of the prisms has been once fixed no focussing that may be necessary alters the effect. The figure shows that the half of the rays which pass to the second prism is that furthest from the observer; in the opposite case the effect would be pseudoscopic.

Plane mirrors of glass may be used instead of the prisms, but the surfaces of both the prisms and the mirrors must of course be perfect. The prism which is inserted half-way, A, is best made equilateral, because with a rectangular one the total reflection might be questionable, and the edge is better; the other may be rectangular, and should be of such a size that when the first is removed it can take in and reflect the full pencil of rays; we then have a monocular Microscope. It is obvious that instead of the eye-pieces described, actual achromatic telescopes could be used."

Fig. 5.



Hartnack's Demonstration Microscope.* — This (Fig. 5) consists of a tube, carrying eye-piece and objective, fixed to a frame by which it can be held in the hand. A micrometer screw *a* serves for focussing the object which is fixed to the circular stage by clamps. The continuation of the stage forms a metallic drum, at the lower end of which is a convex lens L to concentrate light on the object. A diaphragm-disk is inserted in the drum with a portion of its margin projecting on one side so as to be revolved by the finger.

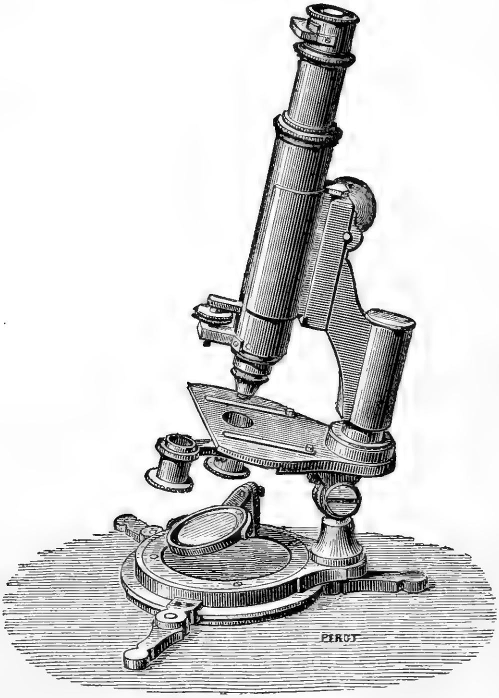
Lacaze-Duthiers' Microscope with Rotating Foot.—M. Nachet has supplied us with a drawing (Fig. 6) of a Microscope similar to that which we described at p. 873 of Vol. III. It is the device of Professor H. de Lacaze-Duthiers.

The speciality of the instrument is that the bottom of the pillar

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 55 (1 fig.).

is attached to a movable ring so that the rotation is on the base and not on the stage (as in the larger Nachet models), the mirror remaining fixed.

Fig. 6.



The special object of the design is stated to have been to reduce the height of the instrument as much as possible, the method adopted for the rotation "allowing the stage to be less elevated above the table and thinner."

Nachet's Portable Microscope.—This Microscope is shown in Figs. 7 and 8 set up for use as a table Microscope. Fig. 8 is intended to show its application to the observation and dissection of large surfaces or objects contained in small troughs or tubs. By loosening the milled ring just above the stage (A, Fig. 8, C, Fig. 9) the compound body can be removed, and an arm L carrying a lens or doublet substituted. To put the instrument in its box (Fig. 11), the stage P (Fig. 10) is turned completely over on the pivot O, and the base is then only 4·5 cm. in height. The box is 19 cm. × 11 cm. × 6 cm.

The instrument seems to be an excellent solution of the problem of constructing a Microscope which shall be really "portable" and at the same time quite steady for ordinary use.

FIG. 7.

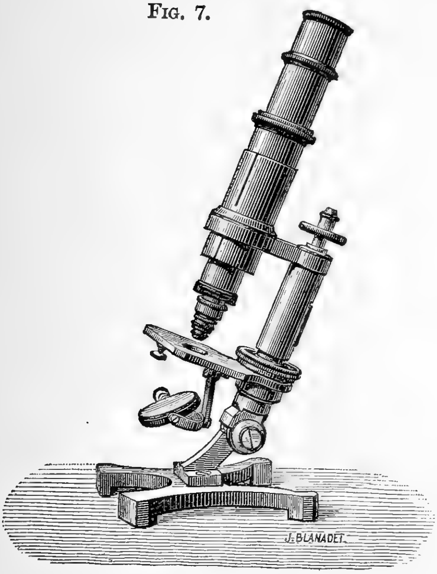


FIG. 8.

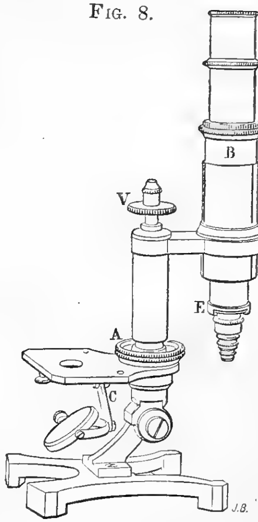


FIG. 9.

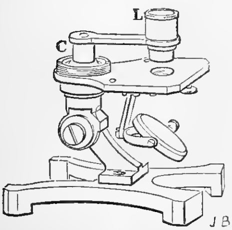


FIG. 10.

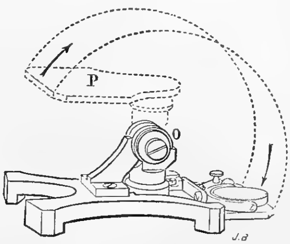
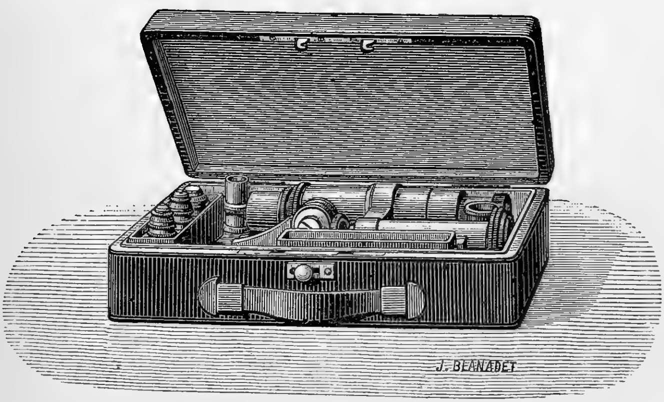


FIG. 11.



Parkes's "Drawing-room" Microscope.—The peculiarity of this Microscope (apart from its title and golden colour) consists in the revival of the "magnetic bar adjustment" to the stage, a device originated by Mr. G. Busk.

Piffard's Skin Microscope.—Dr. Stowell recalls * the Microscope for the examination of the skin, devised by Dr. H. G. Piffard,† to obviate the inconveniences attendant upon a simple lens of high power, which "often involves a constrained position of the head and neck, and in some cases an unpleasant proximity to the subject under investigation."

Dr. Piffard's description is as follows:—"A (Fig. 12) represents the body of a binocular Microscope made by Nachet, from which the

FIG. 12.

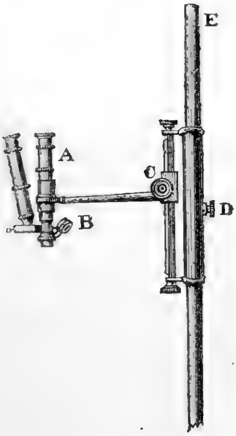
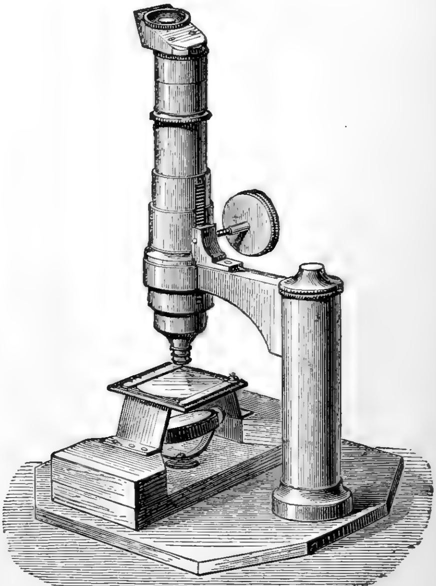


FIG. 13.



reflecting prism situated above the objective was removed, and another of the same focus but double the size substituted. B is a double nose-piece carrying two objectives of different powers. C is the pinion for fine adjustment (raising and lowering the horizontal arm); and D the clamping screw for coarse adjustment, the whole apparatus sliding up and down the rod. E is a rod, five feet in length, which supports the other apparatus, and is itself supported by a cast-iron foot not shown in

* 'The Microscope,' i. (1881) pp. 33–8. (1 fig.).

† 'An Elementary Treatise on Diseases of the Skin, for the use of Students and Practitioners.' (8vo, London and New York, 1876.) See pp. 32–41. (1 fig.)

the drawing. Other adjustments permit the body of the Microscope to be placed in a horizontal or any other desired position. . . . With the instrument described, any portion of the integument, from the scalp to the sole of the feet, can be conveniently examined, and a prolonged examination can be made without fatigue to the observer. It is an instrument which I cannot too highly recommend to those desiring a thorough knowledge of the surface aspect of the skin and its lesions."

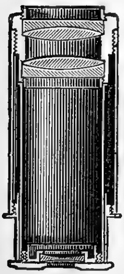
Robin's Dissecting Microscope.—This (made by MM. Nachet) is shown in Fig. 13, with their erecting eye-piece. The stage is arranged so as to provide rests for the hands on either side of the dissecting plate.

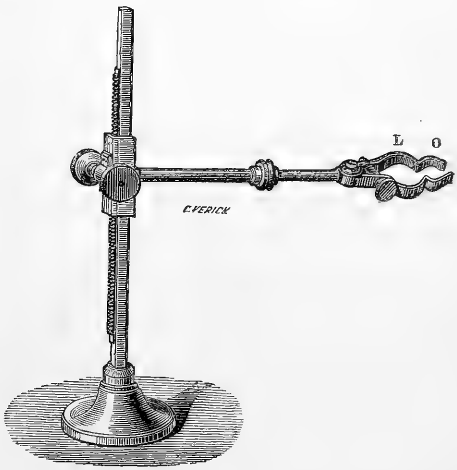
Brücke Lens.—A description of this lens (Fig. 14), much in use on the Continent, does not appear in any of the English books on the Microscope. We take the following from M. Robin's treatise.*

"To remedy the inconvenience of the lens being too close to the object in all but low powers, Charles Chevalier in his 'Manuel du

Fig. 15.

Fig. 14.





Micrographe' (1839) proposed 'to place above a doublet a concave achromatic lens, the distance of which could be varied at pleasure. The effect of this combination is to increase the magnifying power and lengthen the focus. Thus arranged, this instrument will be the most powerful of all simple Microscopes, and the space available for scalpels, needles, &c., will be much greater than with a doublet alone. The further the concave lens is removed from the latter, the greater will be the amplification.' This combination, applied to lenses for examining the eye and skin, allows the use of doublets which leave

* Robin, C., 'Traité du Microscope et des Injections,' 2nd ed. (8vo, Paris, 1877), pp. 33-4 (1 fig.).

a considerable distance above the object, and it is this idea which has governed the construction of the Brücke lens.

"The lens has a very long focus, and the construction is that of the Galileo telescope as applied to opera-glasses, but the amplification of the objective is much greater than that usually obtained in opera-glasses. The focus is about 6 cm., and the power three to eight times. The latter power is obtained by lengthening the tube, by which means the distance between the two lenses is much enlarged and the amplification increased without inconveniently modifying the focus.

"This lens may be used in place of the body of a compound Microscope when it is desired to dissect or to find small objects, or it can be adapted to a simple Microscope or lens-holder with from 3 to 8 cm. between the object and objective."

Künckel d'Herculais devised a holder for the lens shown in Fig. 15. By tightening the screw on the horizontal arm the "jaws" are separated or closed. The arm can be lengthened if desired and also raised or lowered by the rack and pinion. L is the place for the lens and O for doublets.

The Model Stand.*—Mr. J. D. Cox discusses the changes that have taken place in microscope-stands with a view of determining which will be of permanent value and should form part of the features of a complete stand, and thus summarizes the essential requisites which ought to be embodied in every instrument intended for real scientific use.

1. A firm and rigid *arm* having the general character of the Jackson model, carrying the body of the instrument, with coarse and fine adjustments conveniently placed below the body, with perfectly even and reliable motion.

2. A firm ring as the basis of the *stage*, to which any form of stage-plate, plain with clips, glass, or mechanical, may be adapted and interchanged. Nearly every microscopist has work to do for which a mechanical stage is almost indispensable, such as micrometric measurements, and the systematic sweeping of a slide to make sure that every part has been examined. There should be no rack and pinion movement for revolving the stage as it can be better done with the fingers, nor a centering adjustment unless the instrument is intended for goniometry. The stage thin enough to allow the use of light of at least 70° obliquity from the axis of the instrument.

In regard to the requisite of reversibility for the stage, Mr. Cox points out that in nearly every department of natural science (and not for diatoms only) there is need of the occasional use of light of extreme obliquity upon dry mounts and from the mirror alone, so that an easily reversible stage is desirable. If, however, immersion illuminators came to be used for dry mounts as well as those in balsam † a reversible stage would not be necessary, as a ray incident at 41° only would emerge at the maximum obliquity of 90°.

3. A grooved bar—immovable and not swinging—for the support

* Amer. Jour. Micr., vi. (1881) pp. 89–95 (4 figs.).

† This should read "for dry *objectives* as well as immersion." Balsam mounts are on the same footing as dry mounts *when a dry objective is used.*

of the *substage* with centering screws and which may or may not be fitted with rack and pinion movement. No illuminating apparatus to be attached to the bottom of the stage proper. The diaphragm with tapering nose so that it can be racked up close to the bottom of the slide.

4. The *mirror-bar* to swing on the optical centre of the instrument above as well as below the stage, and to have a sliding extension so as to increase the distance between the mirror and the stage without changing the angle of the incident light.

5. Such form of *base* as will permit the mirror to be swung laterally when the instrument is in upright position.

Mr. Cox objects to the substage and mirror-bar swinging together, on the ground that it is then necessary to attach "the immersion illuminators to the bottom of the stage by some special means, such as bayonet catch, screw in the stage-well, &c.," and he advises that all such apparatus should be used in the substage for which it was in fact devised. He suggests and figures an attachment to carry an immersion illuminator, consisting of a movable elbow-piece on a slotted arm sliding on a pin that screws on the outer end of a short right-angled dove-tail slide fitting into a corresponding bar cast on the substage carrier that racks or slides on the fixed tail-piece. This appears to us, however, a complicated way of applying a simple immersion illuminator such as the hemispherical lens, and we cannot see any objection to mounting the lens in a disk to fit into the stage-well or the under surface of the rotating stage plate.

For use with the Continental stands that are not provided with mechanical stages, Mr. Zeiss mounts the lens in a disk of brass which drops into the bevelled central stage opening, the plane face is then flush with the surface of the stage.

Denomination of Eye-pieces and Standard Gauges for same.—The Committee appointed by the Council in October last to consider the question of standard gauges for eye-pieces (and substages) duly presented their report, which was thereupon ordered to be printed and circulated amongst the members of the Council, and is now under consideration.

Subsequently to the report being made, the following circular was received by some of the English opticians from a committee of the American Society of Microscopists, unfortunately too late to be laid before the Committee.

"1*st Question.*—Please give list of various eye-pieces or oculars for the Microscope made by you, with construction (Huyghenian, orthoscopic, periscopic, &c., &c.), with the equivalent amplifying power of each, at a standard distance of 10 English inches or 254 mm.

2. Please state how you determine the amplifying power of your eye-pieces.

3. Do you consider it desirable that a uniform nomenclature (with reference to amplifying power) of eye-pieces should be adopted by makers of Microscopes?

4. Will you adopt such a nomenclature if decided upon by this Society?

5. Please suggest such a nomenclature which seems to you most generally applicable and desirable.

6. Do you consider it desirable that eye-pieces should be so constructed—by means of a shoulder or other device on the longer ones—that all should pass the same distance into the tube of the Microscope, thereby preserving the blackening of the inside of the microscope-tube?

7. Please give inside diameter of microscope-tube, or draw-tube where there is one, or outside diameter of that portion of eye-piece fitting into the microscope-tube for each size of stand made by you.

8. Do you consider it desirable that two, or three, or more *standard diameters* of tube for Microscopes be generally adopted with a view to interchangeability of eye-pieces?

9. Please suggest the number of sizes and the inside diameter of tube in each case, which you would recommend for adoption.

10. Will you adopt a standard set of sizes if agreed upon and recommended by this Society?

11. Please give this committee the benefit of any suggestions not included in the above answers."

The inquiry of the American committee embraces a wider field than that of the Society's committee, which was limited to the question of standard gauges for eye-pieces and substages, and does not include a consideration of the proper denomination for eye-pieces, though the present system of nomenclature is an even greater evil than that of the numerous different sizes.

Every one feels the inconvenience of the Continental method of numbering or lettering *objectives*, a special table being necessary to enable the relative powers of Monsieur A's No. 2, and Herr B's No. 3 to be compared; the English plan of denoting the objective by inches and fractions of an inch is obviously preferable.

Having adopted this improvement, however, and even being accustomed to wonder how our Continental brethren can still tolerate so barbarous a system of marking objectives, it is remarkable that the designation of eye-pieces should have been allowed to remain on the principle abandoned for objectives, and that the letters A, B, C, D, &c., by which they are known, should still express absolutely nothing as to their magnifying power, beyond the fact that D is to some undefined extent more powerful than C, C than B, and B than A; so that not only is it impossible to compare the eye-pieces of different makers, but it is not possible to do so in the case of the same maker, unless the powers are actually known.

If eye-pieces were, however, denoted on the same principle as objectives, nothing whatever would be lost, and much would be gained.

For instance, if the magnifying power of a $\frac{1}{5}$-inch objective with a C eye-piece is required, it will be 500 or 750, according as the eye-piece is that of one or the other maker. If, however, instead of being labelled C (or No. 3), the eye-pieces were called $\frac{2}{3}$-inch or 1-inch, the necessary calculation ($50 \times 15 = 750$ or $50 \times 10 = 500$) is instantly made.

TABLE OF MAGNIFYING POWERS.

OBJECTIVES.		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.	MAGNIFYING POWER.	FOCAL LENGTH.								
		2 in.	1⅓ in.	1 in.	4/5 in.	⅔ in.	½ in.	4/10 in.	⅓ in.	¼ in.
		MAGNIFYING POWER.								
		5	7½	10	12½	15	20	25	30	40
		COMBINED AMPLIFICATION OF OBJECTIVES AND EYE-PIECES.								
in.										
5	2	10	15	20	25	30	40	50	60	80
4	2½	12½	18¾	25	31¼	37½	50	62½	75	100
3	3⅓	16⅔	25	33⅓	41⅔	50	66⅔	83⅓	100	133⅓
2	5	25	37½	50	62½	75	100	125	150	200
1½	6⅔	33⅓	50	66⅔	83⅓	100	133⅓	166⅔	200	266⅔
1	10	50	75	100	125	150	200	250	300	400
8/10	12½	62½	93¾	125	156¼	187½	250	312½	375	500
¾	13⅓	66⅔	100	133⅓	166⅔	200	266⅔	333⅓	400	533⅓
⅔	15	75	112½	150	187½	225	300	375	450	600
½	20	100	150	200	250	300	400	500	600	800
4/10	25	125	187½	250	312½	375	500	625	750	1000
⅓	30	150	225	300	375	450	600	750	900	1200
3/10	33⅓	166⅔	250	333⅓	416⅔	500	666⅔	833⅓	1000	1333⅓
¼	40	200	300	400	500	600	800	1000	1200	1600
1/5	50	250	375	500	625	750	1000	1250	1500	2000
1/6	60	300	450	600	750	900	1200	1500	1800	2400
1/7	70	350	525	700	875	1050	1400	1750	2100	2800
1/8	80	400	600	800	1000	1200	1600	2000	2400	3200
1/9	90	450	675	900	1125	1350	1800	2250	2700	3600
1/10	100	500	750	1000	1250	1500	2000	2500	3000	4000
1/11	110	550	825	1100	1375	1650	2200	2750	3300	4400
1/12	120	600	900	1200	1500	1800	2400	3000	3600	4800
1/13	130	650	975	1300	1625	1950	2600	3250	3900	5200
1/14	140	700	1050	1400	1750	2100	2800	3500	4200	5600
1/15	150	750	1125	1500	1875	2250	3000	3750	4500	6000
1/16	160	800	1200	1600	2000	2400	3200	4000	4800	6400
1/17	170	850	1275	1700	2125	2550	3400	4250	5100	6800
1/18	180	900	1350	1800	2250	2700	3600	4500	5400	7200
1/19	190	950	1425	1900	2375	2850	3800	4750	5700	7600
1/20	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
1/25	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
1/30	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
1/40	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
1/50	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
1/60	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
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 1/15 less and 1/15 more than the figures given in this column.

Judging from past experience, it will probably be too much to expect that the desired change should take place all at once, and that the A, B, C, &c., or Nos. 1, 2, 3, &c., should forthwith be swept away, but we would venture to suggest that the power of the eye-piece should be indicated in the catalogues and elsewhere, as well as the old title, and if this were done we are sure that the latter would soon be wholly disused.

The tables of magnifying powers issued by opticians are at present, in many cases, of a very misleading character, not so much from the fact that the objectives are underrated—a true $\frac{1}{10}$-inch being called a $\frac{1}{8}$-inch—but that, according to the tables, one and the same eye-piece magnifies differently when it is used with different objectives!

We have accordingly compiled the annexed table of magnifying powers for ready reference. It includes all the more usual objectives, and the full series of eye-pieces of Messrs. Beck, Powell, and Ross. It will be noticed that the magnifying powers of the No. 1 or A agree in all three cases, those of the No. 2 or B slightly varying, being 8, 7·4, and 8. It would be an improvement if they could all be made $7\frac{1}{2}$, which would preserve the uniformity of the series. The No. 3 or C vary greatly, being 15, 10, and $12\frac{1}{2}$. The No. 4 or D agree, whilst No. 5 or E are 25, 30, and 25.

We think that an ideal series should run thus:—No. 1 = 5, No. 2 = $7\frac{1}{2}$, No. 3 = $12\frac{1}{2}$, No. 4 = 20, No. 5 = 30.

With the exception of the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$, all the objectives included in the table are actually constructed by English or foreign opticians. As objectives are, however, not uncommonly found to vary somewhat from the designated focal lengths, the figures for the $\frac{1}{13}$, $\frac{1}{17}$, and $\frac{1}{19}$ have been retained.

The length of tube is assumed as usual to be 10 inches.

Braham's Microgoniometer.*—At a recent meeting of the Bath Microscopical Society, Mr. Braham described a microgoniometer for measuring the angles of crystals. "The body of the microscope-tube is formed at right angles. A rectangular prism is so adjusted that the plane of the hypothenuse is at an angle of 45 degrees to the axis of rotation. On bringing any crystal into the centre of the field, a fibre in the focus of the eye-piece is made to coincide with either of its edges so that the degrees passed through can easily be read. Thus, as the instrument measures a magnified image of the crystal, and the object itself is stationary, it will readily be seen that the angles of any crystal visible under the highest powers of the Microscope can easily be measured."

Watson's Sliding-box Nose-piece.—Messrs. Watson have recently contrived a sliding-box nose-piece to carry (1) the vertical illuminator (Fig. 16), or (2) the analyzing prism (Fig. 17) of the polarizing apparatus, or (3) the binocular prism. The application of an extra nose-piece in this form appears to be convenient. Experience must,

* Engl. Mech., xxxiv. (1881) p. 277.

however, decide how far it is advisable to add to Microscopes focussing at the nose-piece, extra appliances tending to affect the delicate fitting of the fine adjustment.

FIG. 16.

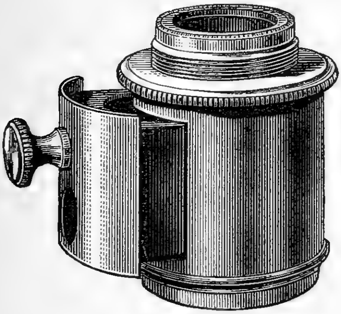
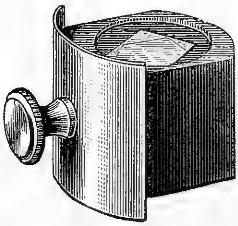
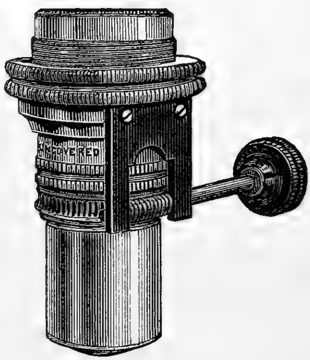


FIG. 17.



Deby's Screw-Collar Adjustment.—Mr. J. Deby suggests that the application of a worm-wheel and tangent screw to the screw-collar adjustment of objectives (Fig. 18) would be found more convenient than the usual system for adjusting the corrections with accuracy. The device, as figured, would not permit the objective to be enclosed in the ordinary brass box; but, as suggested by Mr. Beck, the tangent pinion might be cut off short and provided with a slightly tapering square head upon which the milled head would fit when required.

FIG. 18.



Number of Lenses required in Achromatic Objectives. * —Mr. W. Harkness discusses the number of lenses required in an achromatic objective consisting of infinitely thin lenses in contact, in order that with any given law of dispersion whatever, the greatest possible number of light-rays of different degrees of refrangibility may be brought to a common focus.

For any system of thin lenses in contact we have

$$\frac{1}{f} = (\mu_1 - 1)\,A_1 + (\mu_2 - 1)\,A_2 + (\mu_3 - 1)\,A_3 + \text{etc.}, \qquad (1)$$

the number of terms being unlimited. For a dispersion formula we write

$$\mu = \phi\,(\lambda) \qquad (2)$$

The form of $\phi\,(\lambda)$ is unknown, but there will be no loss of gene-

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 65–7. Smithsonian Misc. Collections, xx. (1881).

rality if it is developed in a series arranged according to the powers of λ. We, therefore, have

$$\mu = a + b\,\lambda^m + c\,\lambda^n + e\,\lambda^p + \text{etc.}, \tag{3}$$

in which a, b, c, etc., are constants, and the number of terms may be taken as great as is desired.

Let us also put

$$\begin{aligned} C &= A_1 (a_1 - 1) + A_2 (a_2 - 1) + A_3 (a_3 - 1) + \text{etc.} \\ D &= A_1 b_1 + A_2 b_2 + A_3 b_3 + \text{etc.} \\ E &= A_1 c_1 + A_2 c_2 + A_3 c_3 + \text{etc.} \\ F &= A_1 e_1 + A_2 e_2 + A_3 e_3 + \text{etc.} \\ &\quad \text{etc.} \qquad \text{etc.} \qquad \text{etc.} \end{aligned} \tag{4}$$

the number of these equations, and the number of terms in the right-hand member of each of them, being the same as the number of terms in the right-hand member of (3). Now substituting for the μ's in (1) their values in terms of the auxiliaries C, D, E, etc., of the equations (4), we find

$$\frac{1}{f} = C + D\,\lambda^m + E\,\lambda^n + F\,\lambda^p + \text{etc.} \tag{5}$$

Considering λ as the abscissa, and f as the ordinate, this is the equation of the focal curve. Its first derivative, with respect to f and λ, is

$$\frac{df}{d\lambda} = -f^2 (m\,D\,\lambda^{m-1} + n\,E\,\lambda^{n-1} + \text{etc.}), \tag{6}$$

which, as is well known, expresses for every point of the curve the tangent of the angle made by the tangent line with the axis of abscissas. The number of rays of different degrees of refrangibility which can be brought to a common focus will evidently be the same as the number of times that the focal curve intersects the focal plane. But the focal plane is necessarily parallel to the axis of abscissas; and therefore the greatest possible number of intersections of the curve with the plane can only exceed by one the number of tangents which can be drawn parallel to the axis of abscissas. To find these tangents we equate (6) to zero, and obtain

$$0 = m\,D\,\lambda^{m-1} + n\,E\,\lambda^{n-1} + \text{etc.} \tag{7}$$

As λ can never be either zero, negative, or imaginary, we have to consider only the real positive roots of this equation; each of which corresponds to a tangent. To make the number of tangents as great as possible, the quantities D, E, F, etc., must be independent of each other; which will be the case when the right-hand members of the equations (4) contain as many A's as there are powers of λ in the dispersion formula (4). All the terms of (7) contain the common factor λ^{m-1}. Taking it out we have

$$-m\,D = n\,E\,\lambda^{n-m} + p\,F\,\lambda^{p-m} + \text{etc.}, \tag{8}$$

from which it is evident that the number of real positive roots in (7) will always be one less than the number of powers of λ in (3). Hence we conclude that:—

In any system of infinitely thin lenses in contact, the number of lenses required to bring the greatest possible number of light-rays of different degrees of refrangibility to a common focus is the same as the number of different powers of λ contained in the dispersion formula employed.

The method made use of in arriving at this result has been adopted, because it brings out clearly the geometrical relations of the problem. The result itself is evident from a mere inspection of equation (5), which cannot possess more real positive roots than it has independent auxiliaries, D, E, F, etc.

Colour Corrections of Achromatic Objectives.*—The following abstract is published of a paper by W. Harkness:—

1. From any three pieces of glass suitable for making a corrected objective, but not fulfilling the conditions necessary for the complete destruction of the secondary spectrum, it will always be possible to select two pieces from which a double objective can be made that will be superior to any triple objective made from all three of the pieces.

2. The colour correction of any objective is completely defined by stating the wave-length of the light for which it gives the minimum focal distance.

3. An objective is properly corrected for any given purpose when its minimum focal distance corresponds to rays of the wave-length which is most efficient for that purpose. For example: in an objective corrected for visual purposes, the rays which seem brightest to the human eye should have the minimum focal-distance; while in an objective intended for photographic work the rays which produce the greatest effect upon silver bromo-iodide should have the minimum focal-distance.

4. In the case of a double achromatic, the secondary spectrum (or in other words, the diameter, at its intersection with the focal plane, of the cone of rays having the maximum focal length) is absolutely independent both of the focal length of the combination, and of the curves of its lenses; and depends solely upon the aperture of the combination, and the physical properties of the materials composing it.

5. When the focal curve of an objective is known, and the relative intensity, for the purpose for which the objective is corrected, of light of every wave-length is also known; then the exact position which the focal plane should occupy can be readily calculated.

Incidentally, it may be remarked that in an objective corrected for photographic purposes the interval between the maximum and minimum focal distance is less than in one corrected for visual purposes. Hence a photographic objective has less secondary spectrum, and is better adapted for spectroscopic work, than a visual objective.

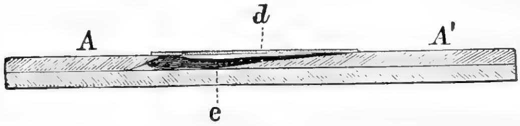
Verification of Objectives. — The editor of the 'Northern Microscopist' undertakes, for a nominal fee of 1*s.* 6*d.*, to verify

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 39–40. Smithsonian Misc. Coll., xx. (1881).

objectives sent to him in regard to their amplifying power, working distance, absolute size of field, and real aperture.*

Schultze's Tadpole - Slide.† — This slide (or "microscopic aquarium") (Fig. 19) was devised for showing the circulation of the blood or the development of the blood-vessels in the larvæ of the frog and triton. To one side of a thick slide is fastened by means of

Fig. 19.

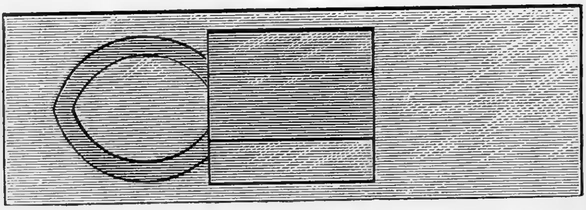


Canada balsam a piece of another slide, cut as represented at A, and to the other side a second piece, of the shape seen at A′, so that there is a small cell in the centre of the slide, of the form shown in section in the figure. A cover-glass *d* closes the cell.

To place the larva *e* in the cell, the cover-glass is taken off and the larva fished out of the water in a small watch-glass, and poured with the water into the cell. By manipulating with a brush, its head is brought into the hollow of the glass at A, and the tail placed on the sloping surface at A′. The cover is then quickly replaced, care being taken that the cell is full of water. The animal is excluded from air by the water, which, when it evaporates, can be replaced with the brush. In this way the circulation of the blood in the tail may be observed for hours at a time.

Stokes' Tadpole-Slide.‡—Mr. A. W. Stokes fastens two pieces of a vulcanite ring (Fig. 20) to an ordinary slide so as to form an oval cell just large enough for the body of the tadpole, the tail projecting through an opening in the cell. Close to the latter a square of thin

Fig. 20.



cover-glass is cemented by Canada balsam so as to raise the tail to a level with the body. On each side of this are cemented two small oblong pieces of thin glass forming a cell for the tail to lie in. A square of cover-glass over the body, and another over the tail, will keep the tadpole in place.

* North. Microscopist, i. (1881) pp. 253–7.
† Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 148–9 (1 fig.).
‡ Ann. Rep. Postal Micr. Soc., 1881, p. 13 (1 fig.).

"Swinging Substage," or "Swinging Tail-piece."—At the time this contrivance was first introduced it was known as a "Swinging Tail-piece," but since that time the term "substage" has been almost universally substituted. The earlier name is obviously, however, the more appropriate, as it is not simply the substage which swings, but the mirror also, and we intend to adopt in future the expression "swinging tail-piece."

Value of Swinging Tail-pieces.—In addition to the opinions cited at p. 666 of Vol. I. (1881), the following has been published during the past year :—

Mr. J. D. Cox, in the paper above referred to (see p. 102), considers that the swinging of the mirror-bar on the optical centre of the instrument is a positive improvement, but that the swinging of the substage is of very doubtful value. "In the former case several real advantages are gained. First, the mirror is kept at its proper focal distance from the object. Second, it may be swung above the stage for illumination of opaque objects. Third, it allows the instrument to be used for measuring aperture of object-glasses, by converting it into Smith's 'Universal Apertometer.'* But when we ask for the advantages of swinging the substage with illuminating apparatus, it is difficult to find them. It is plain that we don't want to swing the polariscope, the parabola, the dark wells, the Webster condenser, the wide-angled achromatic condenser, or the immersion illuminators, and could not if we would, for the form and mounting of these accessories is inconsistent with doing so. The question must practically be narrowed to the desirability of swinging the diaphragm and the low-angled achromatic condenser. Of course none of the flat diaphragms can be swung in this manner, and no advantage seems to be found in the use of the sharp-nosed diaphragms with oblique light. The fact is that there are advantages in taking oblique light directly from the mirror; for the chromatic fringes at the margin of the illumination often enable the microscopist to modify the light in a way to get increased resolution by turning the mirror so as to take the most lateral rays and those nearest the blue end of the spectrum. More range in quality of illumination can be got by the practised hand in this way than by the oblique use of the diaphragm.

"In the use of an achromatic condenser, it must be a very low angle indeed which will work far enough from the bottom of the stage to allow much swinging to right or left, especially when we take into account the fact that the centering of the substage becomes more important when it is swung away from the axis of the instrument.

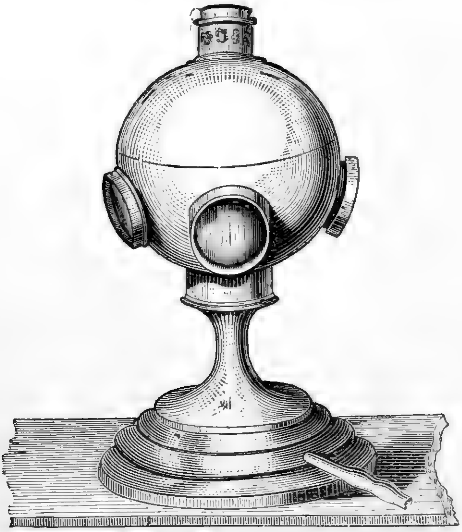
"The centering arrangement of the substage will occupy so much lateral room that it can be swung but a little way before striking the stage. Again, any achromatic condenser of even moderate angle can be swung very little to right or left before its marginal rays will become parallel to the bottom of the slide containing the object under examination, and they then, of course, cease

* See this Journal, ii. (1879) p. 775.

to penetrate to the object or be of use for illumination. Still, again, experience seems to prove very conclusively that the most effective as well as the simplest arrangement for securing oblique light (otherwise than from the mirror alone) is by the prism, the traverse lens, the Wenham 'half button,' or other immersion substage illuminators. These considerations lead strongly to the conclusion that the swinging of the substage is useless."

Ranvier's Microscope-Lamp.*—This (Fig. 21) is described as consisting essentially of a metal globe, which covers the cobalt glass lamp chimney "and prevents the radiation of heat." Four openings with plano-convex lenses conduct the light to four Microscopes. "The light can be so subdued that it is possible to work a long time

FIG. 21.



in the evening without straining the eyes, for which reason the lamp is preferable to all other kinds of illuminating apparatus. The cobalt glass is an essential feature, because the yellow-colour of the lamp-light is thereby obviated, and the sensation of white is produced. Certain shades of yellow and blue, as is well known, stand in relationship to each other as complementary colours, that is they produce white."

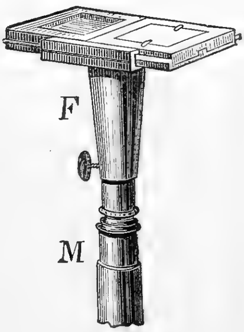
Hollow Glass Sphere as a Condenser.†—Mr. F. Kitton describes the effects of using a glass globe filled with water for the purpose of condensing light upon the object. This was used by some of the early microscopists,‡ though it appears soon to have fallen into disuse, as it

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 73–4 (1 fig.).
† Sci.-Gossip, 1881, pp. 274–5 (1 fig.).
‡ Hooke, 'Micrographia,' 1665; Ledermüller, 'Mikroskopische Gemüths- und Augen-Ergözung,' 1762.

is not mentioned by Adams in his 'Micrographia Illustrata,' 1771, or in his 'Essays on the Microscope,' 1787. Mr. Kitton tried it first with a $\frac{1}{4}$-inch objective upon *Pleurosigma angulatum*, using oblique light from the mirror; the striæ came out very distinctly. On removing the globe, the striæ vanished and required a more oblique ray to render them again visible. Tried on *Synedra robusta*, it resolved the striæ into beads. With a $\frac{2}{3}$ inch, and not altering the previous position of the mirror, a "black field" was obtained. The object *Haliomma Humboldtii* was seen with beautiful effect, appearing as though illuminated by intense moonlight with a slight green tinge and delightfully cool to the eye. It is also to be recommended with polarized light for softness of tint and impenetrable blackness of field when the prisms are crossed. A globe (6 inches in diameter) should be used, filled with a dilute solution of sulphate of copper (about $\frac{1}{2}$ ounce of saturated solution to 1 pint of water). The mixture must be filtered if ordinary water is used, though the intensity of colour is somewhat a matter of taste. The distance of the globe from the lamp should be about two or three inches; from the globe to the mirror about eight to twelve inches.

Stein's small Microphotographic Apparatus.*—Fig. 22 shows Stein's microphotographic apparatus which, though small and simple, is said to answer its purpose completely. It is on the plan of Harting's apparatus and consists of a cone F which is inserted into the tube M of the Microscope instead of an eye-piece, a plate of ground-glass is fixed to the top, and on this the image can be focussed, the observer's head being covered with a black cloth. The ground-glass plate is replaced by the prepared sensitive plate and the image can then be readily photographed.

Fig. 22.



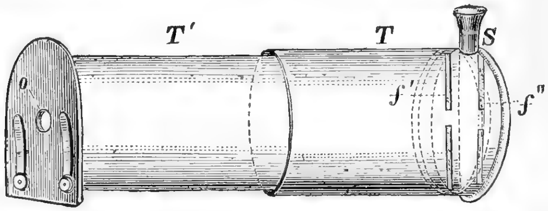
Ranvier's Myo-Spectroscope.†—In this simple and ingenious instrument (available for rapid superficial demonstrations) a prism is replaced by the muscular tissue, the transverse striæ of the muscular bundles acting on white light like a grating and producing spectra.

The muscles of the frog are the most suitable for observation, and especially the sartorius muscle, the bundles of which are parallel. The muscle having been taken with care from a living frog, it is dried for some hours in a stove at 40° C., after having been stretched with pins on a piece of cork. The muscle is then planed on both sides with a sharp scalpel, soaked in turpentine, and mounted in Canada balsam.

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, p. 48 (1 fig.).
† Ranvier's 'Traité technique d'Histologie,' Paris, 1878–80, pp. 316–19 (1 fig.).

The myo-spectroscope is shown in Fig. 23. T′ is a tube 12 cm. long and 4 cm. in diameter, blackened internally, and closed at one end by

Fig. 23.



a diaphragm with a vertical slit f' half a millimetre in breadth. At the other end is a stage plate with a central hole *o* (5 cm.). The preparation of muscle is placed in the clips in front of the latter hole and so that the axes of the muscular bundles are at right angles to the slit f'. On looking through the hole, whilst the instrument is directed to a light, spectra will be seen on the right or left of the slit.

To observe the absorption-bands of hæmoglobin, a second tube T is added to the instrument, sliding over T′ and having a diaphragm with a large vertical slit f'' in which is placed a tube S containing a solution of blood. Having first seen that the muscle gives a clear spectrum, T with S is replaced and the two absorption-bands of hæmoglobin will be seen in the spectrum.

As the spectrum produced by a grating is more extended according as the lines of the grating are closer together, we are led to investigate whether a muscle at the moment of contraction gives a wider spectrum than when at rest. The lower tendon of the sartorius muscle of a frog is separated from the tibia and the muscle stretched before a slit and it will be seen that on slightly stretching the muscle, the spectrum will be narrow and close to the slit. When the muscle is contracted the converse phenomena are produced, and when it is excited by a current and attains its maximum of contraction the width of the spectra and their distance from the slit are much augmented.

The muscles of different animals thus examined do not give identical spectra. For example, those of the muscles of the frog are broader than those of the white muscles of the rabbit in the ratio of 9 : 7. The transverse striation is therefore finer in the former case than in the latter.

Standard for Micrometry.*—The Philosophical Society of Washington publishes the reply given by Dr. J. J. Woodward to the committee of the Microscopical section of the Troy Scientific Association who asked answers to the following questions:†—

"1. Is it expedient at present to adopt a standard for micrometry?

2. If so, should the English or the metric system be employed?

* Bull. Phil. Soc. Washington, iii. (1878–80) pp. 22–4; Smithsonian Misc. Coll., xx. (1881).

† See this Journal, ii. (1879) pp. 154–5.

3. What unit, within the system selected, is most eligible?

4. What steps should be taken to obtain a suitable standard measure of this unit?

5. How can this standard micrometer be best preserved and made useful to all parties concerned?"

The reply was as follows:—

"1. I am in favour of the adoption of a suitable standard for micrometry by the American Society of Microscopists at their next meeting.

2. For this particular purpose I think the metric system offers so many conveniences that I favour its employment.

3. The selection of an eligible unit within the system involves, it appears to me, two distinct questions: A. How shall the stage-micrometer be ruled? B. How shall the measurements made, be expressed in speech or writing?

A. The object of the stage-micrometer is chiefly to give values to the divisions of the eye-piece micrometer with the power used in any given case. It should be long enough to be used for this purpose with the lowest powers of the compound Microscope, and have a part of its length ruled sufficiently close to answer the same end with the highest powers. I favour the adoption of a standard scale a centimetre long ruled in millimetres, and one of these ruled in hundredths. I have used stage-micrometers ruled in thousandths of a millimetre, but regard such divisions as inconveniently close for this purpose. To measure in thousandths of a millimetre as the unit, which is very convenient in a large number of cases, the simplest way is to use a magnifying power that will make ten divisions of the eye-piece micrometer exactly coincide with one-hundredth of a millimetre on the stage-micrometer. The glass eye-piece micrometer should have a scale a centimetre long ruled in one hundred parts. By increasing the power so that a larger number than ten of these divisions shall correspond to one-hundredth of a millimetre on the stage-micrometer, a unit of any degree of minuteness that may be required for any special work can be obtained up to the limits of distinct vision with the Microscope.

B. But although I regard the hundredth of a millimetre as a very eligible dimension for the closest divisions of the stage-micrometer, when it comes to expressing the results of our measurement in speech or writing, I do not think it is convenient to use the hundredth of a millimetre as the unit of expression. It is too large, and the results of too many measurements would still have to be expressed in decimal fractions. The thousandth of a millimetre is much more convenient as a unit of expression, and I would advise that microscopists should agree to call this dimension a *micron*, and represent it in writing by the Greek letter μ. This dimension has already been adopted as the unit of expression by a number of European microscopists, who represent it by the same Greek letter, but call it a micro-millimetre. The term *micron* should, I think, be preferred because well known to scientific men other than microscopists, having for some time been used in expressing minute differences by those officially engaged in preparing standard measures of length, and having been adopted by the International Metric Commission. I think it running an unnecessary risk of confusion to select any other than this well-recognized term for the dimension in question.

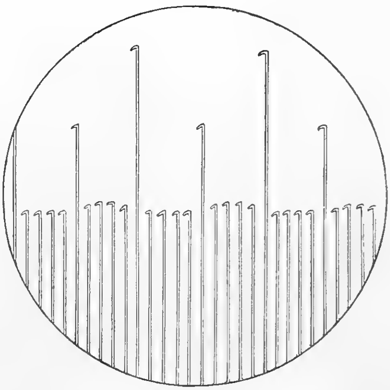
4 & 5. To obtain a suitable standard stage-micrometer, I would advise each microscopical society to select one ruled, as above described, by any person in whom they have confidence, and to satisfy themselves by comparison of the several parts with each other, by means of the same part of the eye-piece micrometer, that the divisions agree among themselves. This is comparatively easily done; the real difficulty will be to determine whether the whole scale is really a centimetre long. To ascertain this, I would advise each microscopical society to send its standard micrometer to the Superintendent of the Coast Survey at Washington, with the request that he will have it compared with a recognized standard in the Bureau of Weights and Measures, and return it with a report of the error, if any. I have reason to believe that such requests would be promptly and courteously responded to. Each society should then preserve the standard thus obtained for the sole purpose of enabling its members to compare their stage-micrometers with it. I think this plan much wiser than to relegate the question to any one of the ingenious men who are endeavouring in this country, with considerable success, to make accurate rulings on glass, and I should anticipate better results from it than from the appointment of a special committee of the American Society of Microscopists to prepare a standard scale.

In conclusion, I readily admit that so long as the English microscopists continue to express the results of their measurements in decimals of an English inch, there will be American microscopists who will do the same, either for all purposes or for particular work, and of course it is very desirable that these measurements also should be accurate. The stage-micrometers on this system in the market are usually ruled in hundredths and thousandths of an inch. The latter divisions are too wide to give values to the eye-piece micrometer with the higher powers, while the five-thousandths, ten-thousandths, or even finer divisions, ruled also on some of these micrometers, are inconveniently close. I would advise the makers to rule such micrometers four-tenths of an inch long, divided into hundredths of an inch, one of the hundredths being subdivided into ten, another into twenty-five spaces. These latter spaces, each representing one twenty-five-hundredth of an inch, sufficiently approximate the hundredth of a millimetre to be used with equal convenience with the higher powers. The scale on the glass eye-piece micrometer, used with these stage-micrometers, should be, if specially made for the purpose, four-tenths of an inch long, divided into one hundred parts, each one two-hundred-and-fiftieth of an inch; but these divisions would so closly approximate those of the metric eye-piece micrometer proposed, that it might be used without inconvenience instead. Where it is thought worth while by a microscopical society to procure a standard scale of this kind, it should be sent to the Coast Survey Office for measurement, as in the case of the metric scales."

Rogers' Micrometers.—Prof. W. A. Rogers, of Cambridge, U.S.A., recently offered, as we announced,* to present a ruled stage micrometer to any one who would undertake to examine its divisions and publish the results. Mr. T. S. Bazley having accepted the proposal, now details the result of the investigation.† "Placed on the stage, and viewed with a two-thirds objective, and a dark field, the ruled lines, which are not filled in with a dark pigment as is common, sparkle like streaks of diamonds; and under this illumination a singular appearance is noticed. In some of the lines a slight internal splintering of the glass has apparently followed the course of the ruling-point, giving an effect of deeper cuts in certain places. But, as this effect is invisible with a bright field, and as there is certainly no variation in the width of the several lines, it probably arises solely from the nature of the glass; and the more so, as these apparently deeper cuts do not often extend for the entire length of a line, and sometimes occur side by side for a few lines.

"The micrometer is of the ordinary 3 by 1 size. The ruled portion is a centimetre in length, and contains 1000 spaces, subdivided at every fifth and tenth, the lines being thus 0·01 mm. apart. The width of the band, neglecting those lines that project, is 1·375 mm. Every tenth line is 1·6 mm. long, and the principal spaces of 6·1 mm. are subdivided by a shorter prolongation of the fifth lines, which measure 1·55 mm. These measurements are the average only, for the lengths of the individual lines vary a few thousandths of a millimetre, and the lower edge of the band is not consequently strictly in one straight line. The terminations of the lines at the upper edge, independently of those projecting at every fifth and tenth, are not in the same straight line either. These deviate in a symmetrical manner; four lines between two long ones having their ends equal and straight, while the ends of the next four form a gentle convex curve. All the lines at this, which may be considered the reading edge of the band, are terminated by singular hooks, suggestive of the curved handle of a walking-stick (see Fig. 24); they differ somewhat in size and character, but have all the same direction, and are probably due to the stopping, lifting, and reversal, of the cutting diamond.

FIG. 24.



"The objectives used were a series by several makers (dry, as well as immersion adapted to various media) up to Zeiss's L, equivalent to

* See this Journal, i. (1881) p. 678.

† Engl. Mech., xxxiv. (1881) pp. 341–2 (1 fig.).

$\frac{1}{24}$; the lines of the band being well defined under all of them; and the eye-piece micrometer, Jackson's form, and a small spider-line micrometer. The former depends a good deal for its result upon an estimation to tenths of its graduations, and can hardly be susceptible of the accuracy which should be attained with a well-made 'wire micrometer.' The latter was therefore adopted and provided with additional draw-tubes, for use, either as an eye-piece in the usual manner, or in the substage, giving an aerial image of the spider-lines as proposed by Dr. Pigott.* This latter method, however, so far as my own experience goes, is more ingenious than effective; principally because all vibration of the micrometer in that position is magnified by the whole power of the Microscope. There is one advantage possessed by Jackson's in the spring action, which moves the whole scale, and consequently its zero point, with extreme nicety. In the spider-line micrometer, one wire is generally fixed, and the only way to bring a given point of an object under the Microscope to coincide with that wire is by the screw action of the stage, which, with a high power, is far too sensitive and rapid. To obviate this difficulty, a traversing movement to the extent of a fifth of an inch, controlled by a screw of fine pitch, was added to the small micrometer between its screw-plate and draw-tube. By this means any given line on the ruled band, after being brought approximately into position with the stage movement, could be accurately bisected by the fixed wire of the micrometer. The objectives finally selected were a $\frac{1}{4}$ for the measurement of the principal subdivisions of 0·05 mm. each, and a $\frac{1}{10}$ imm. for the close spaces. These objectives gave the most convenient decimal values; the former by suitable adjustment of the draw-tube giving ·00025 mm. as the equivalent of one division of the micrometer divided head (50 divisions to one turn); and the latter ·0001 mm. Both glasses were by Beck, and their magnifying powers, with the positive eye-piece employed, were 950 and 2500 respectively. Of course the eye-piece could be changed at pleasure, without altering the ratio of scale to image. The fine movement of the Microscope employed is on its main tube; its action propels or withdraws the nose-piece, thus possibly interfering with the value, as adjusted by the lengthening draw-tube, of the micrometer scale in terms of a given unit. It proved, however, by actual experiment, using a power of 1000 diameters, that an alteration of the fiftieth of an inch in the distance from eye-piece to stage, made no perceptible change in the ratio between the micrometer in the eye-piece and that on the stage, so any supposed error in measurement from this cause may be dismissed as visionary. All kinds of illumination were tried, the preference being given to that described [in this Journal, I. (1881) p. 666], using the concave mirror without condenser, at an obliquity of about 40°, and a thin metal plate attached below the stage, at such an angle that no rays from the lamp can reach the object, except by reflection from the inclined mirror. With the light so directed, each line of the band was evenly divided, longitudinally, into a dark half and a light half, giving much facility for the exact superposition of a

* Mon. Micr. Journ., ix. p. 3.

micrometer-wire upon the centre of the image of any line. In examining the spaces seriatim, there was some risk of losing count, and as a means of reference, a scale of figures, photographed by Mr. J. Mayall, jun., to the exact length of a centimetre, was pasted at the upper edge of the band, so that the principal graduations of the latter could be identified with a low power.

"Coming, at last, to the examination of the plate ruled by Prof. Rogers, perhaps its most distinguishing feature is the perfect straightness and similarity of the individual lines. The stage micrometers commonly met with are so deficient in this respect, that it is impossible to obtain equal distances from different parts of the same two lines of the scale. But with the rulings of Prof. Rogers no such inequality exists. The spider-lines at the eye-piece may be set to any interval of lines on his micrometer, and the scale will rigidly indicate the same distance at any other part of the band, whether above, below, or on either side the position first selected. As to the actual width of the lines themselves, I make it to be ·001 mm. almost exactly. After all these precautions for the study of this micrometer, perhaps a list of small, though definite, errata may be looked for; but I have carefully verified the principal intervals of the band, and a large number, taken at hazard, of the 1000 close spaces, and have detected no discrepancies whatever. The only possible criticism that occurs to me is that the projecting lines at the reading edge are perhaps needlessly long, and that if the 'walking-stick hooks' could be transferred to the other side of the band, it would be an improvement. I believe the ruling to be as accurate as mechanical means can produce; and though there is no means of deciding whether the spaces are true subdivisions of the French metre, the perfection of the subdivisions themselves is a tolerably sure guarantee that the Professor took every care to verify his unit to begin with."

Section of "Histology and Microscopy" at the American Association.—At the last meeting of the American Association for the Advancement of Science, a section of "Histology and Microscopy," in place of the previously existing sub-section of Microscopy, was established, to rank on the same footing as the other sections of the Association, and to be represented on the Standing Committee, its Chairman being *ex officio* a Vice-President.

Structure of Cotton Fibre.*—Dr. F. H. Bowman has published an elaborate investigation into the structure of cotton fibre, in which he gives a general account of the plant botanically, and deals with the typical structure of a cotton fibre, both in regard to the mechanical arrangement of its ultimate parts, and chemically. A full consideration is given to the variations from the type structure which are found to exist and the extent to which any variation in the ultimate fibre may affect its use in the manufacturing process.

The book is illustrated with plates of typical and other cotton

* Bowman, F. H., 'The Structure of the Cotton Fibre in its relation to technical applications,' xvi. and 211 pp., 5 figs. and 12 pls. 8vo, Manchester, 1881.

fibres and with coloured plates, showing their appearance when dyed with turmeric yellow, indigo blue, &c.

The value of the Microscope with ordinary and polarized light, and with dyed and undyed fibres, is throughout made a special feature, and the book is to be welcomed as a noteworthy addition to the, at present, very scanty literature relating to the practical applications of the Microscope to manufactures. We should imagine that both silk and woollen manufacturers would be benefited by similar treatises on silk and wool.

The limit of microscopical *vision* is, on pp. 156–7, treated as synonymous with the limit of microscopical *resolution*, and in any future references to the subject care should be taken to show that the latter refers exclusively to the power of distinguishing as separate two lines or other objects close together, the limit of which is half the wave-length in the medium employed × sin. u, whilst the vision of isolated minute objects is only limited by the sensitiveness of the particular observer's retina, the distribution of light, &c. Limit of "visibility" is distinct from the limit of "visible separation."

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

Durable Preparations of Microscopical Organisms.*—Professor G. Entz describes the method used by him for mounting microscopical organisms, Protozoa, Rotifera, &c., preceded by an historical review of the processes hitherto adopted.

Ehrenberg † used a dry process which answered well only for certain objects. Its use may be somewhat extended by soaking the dried preparation in 1 part distilled water, 1 part glycerine, and (in a large quantity) 1–2 drops of picric acid. The shrivelled parts swell out and look very life-like. Amongst the organisms capable of being so treated are the Volvocineæ, Chlamydomonads, the loricated *Euglenæ* (*E. acus* and *E. Spirogyra*) Peridineæ, the tests of Rhizopods, tubes of *Melicerta*, Ciliata with resisting cuticles (as *Stentor igneus*, *Epistylis plicatilis*, and fine chitinous elements, such as the masticatory apparatus of Rotifera and small Nematodes. The protoplasmic parts of organisms are of course entirely lost by this method.

Later still, Du Plessis ‡ suggested glycerine coloured with chromate of potash, and Duncker § in 1877 exhibited Rotifers, Protozoa, and Algæ, which were highly commended by such authorities as Cohn, Stein, and Leuckhart, and which showed the fine parts in a most wonderful manner. Unhappily they were not permanent. In a few weeks brown oily drops began to make their appearance in the fluid, and ultimately the protoplasm also browned, so that they are now useless. Duncker never published his method, but the author considers it probable that the basis of the fluid he used was rectified

* Zool. Anzeig., iv. (1881) pp. 575–80.
† Abh. K. Akad. Wiss. Berlin, 1835, p. 141; 1862, p. 39.
‡ Arch. f. Naturg., 1864, ii. Band, p. 162.
§ See this Journal, i. (1878) p. 221.

pyroligneous acid, which, allowed to run in under the cover-glass in small quantities, killed and fixed the organisms in their natural form.

After referring to the methods suggested by Certes,* Bütschli,† and Thanhoffer and Davida,‡ the author describes that which he has adopted in the hope of obtaining the same beautiful results as Duncker, but at the same time more durable.

"According to my experience, various means, long known, are adapted for fixing the smallest and most delicate organisms; for instance, rectified pyroligneous acid, the 'liqueur salin hydrargyrique' of Blanchard, in the mixture which Arnold Lang recommends for preserving marine Planarians, § and which has been also used by Paradi for fixing fresh-water Turbellarians with the best results; also picric acid; and lastly, what Paul Mayer has so strongly recommended || for the lower animals, viz. picro-sulphuric acid, which certainly should have the preference over the others. All these media (the list of which is by no means exhausted), kill microscopical organisms instantaneously, without destroying their organization. Flagella and cilia, the suctorial disks of the *Acinetæ*, and even the fine pseudopodia of the Heliozoa can be fixed as well as the pedicel of the rapidly-jerking *Vorticellæ*. Also the muscle of the pedicel, the contractile vacuoles, and the œsophagus and digestive vacuoles. *Euglenæ* and *Amœbæ* may be fixed in their various changing shapes. Rotifera die mostly with their peristomes moderately withdrawn, and *Vorticellæ* the same; but examples may be obtained from *Carchesium*- and *Epistylis*-stems, which are fixed in the act of lively rotation. Infusoria are fixed in the same life-like state, in the act of fission or conjugation, and *Vorticellæ* in the bud form of conjugation. The nucleated elements also come out very prominently, even the nucleolar capsules can be splendidly preserved for further study, and their striation retained. *Spongillæ*, *Hydræ*, small Nematodes, Tardigrades, delicate insect larvæ, and ciliated cells (e. g. of the gills of mussels) can be excellently fixed and preserved. To obtain durable preparations, however, it is absolutely necessary to remove the fluid which has completed its work in the process of fixing, as it might injure the fine organisms by longer action, afterwards placing the preparation in a fluid which is suited to it.

"My procedure is essentially the same as that which Paul Mayer used for treating the lower marine animals with picro-sulphuric acid.

"I place the Protozoa and other microscopical organisms with the Algæ, sediment, or other objects to which they are affixed or between which they move, with some water in a watch-glass, then drop in a few drops of the fixing fluid, which I allow to act only 1–2 minutes. I then pour off the fluid carefully, or simply lift the

* Comptes Rendus, lxxxviii. (1879) p. 433. See this Journal, ii. (1879) pp. 331 and 763.

† Zool. Jahresber., 1879, p. 173.

‡ Thanhoffer, L. v., 'Das Mikroskop und seine Anwendung,' 1880, p. 110.

§ Zool. Anzeig., i. (1878) p. 14. See this Journal, i. (1878) p. 256.

|| MT. Zool. Stat. Neap., ii. (1880) pp. 1–27.

preparation out with a pencil or scalpel, in order to transfer it at once into a larger quantity of alcohol, which must not be too strong. Half an hour is usually enough to withdraw the fixing fluid and replace it by alcohol, in which it may remain a longer time without damage. For removing the chlorophyll colouring-matter of many Infusoria, and also the Algæ in the preparation, a longer stay in alcohol is of course necessary, replacing it by clear alcohol when it has become coloured.

"Microscopical organisms thus treated are ready to be at once mounted in dilute glycerine (1 part of distilled water to 1 of glycerine). But colouring must not be neglected. Among the colouring materials commonly used (carmine, hæmatoxylin, and various aniline dyes), carmine certainly is to be preferred, because it is not bleached in glycerine, and moreover does not colour everything with one tint like the aniline dyes, but principally the nuclear elements. Preparations transferred from alcohol to carmine are mostly coloured sufficiently in 10–20 minutes, only loricated forms as *Euglena*, *Spirogyra* and species of *Phacus*, the Peridineæ, &c., require several hours to make their nuclei sufficiently prominent. Before being transferred into dilute glycerine, the preparations must of course be put into distilled water, and remain until the yellow picric acid is drawn out, and the preparation shows a nice rose colour.

"By the above process beautiful and instructive preparations are obtained, which when carefully mounted show no further change. I have a fairly considerable collection of different Protozoa which have not altered in the least for 6–7 months, and are adapted both for demonstration and for detailed study."

Preparing Anthers.*—J. Rataboul proposes an improved method for preparing anthers, to show the fibrous cells of their walls.

The ordinary method of preparation is to leave the anthers in water until the walls swell, and by triturating with a quill to loosen some shreds of tissue. If any cells are found the tissue must be washed with care to remove pollen-grains and air-bubbles. These manipulations are long, delicate, and difficult, and are not always successful; and the author's method is to place the anthers in 90° or 100° alcohol for 4–5 minutes, triturating *grosso modo*, and immediately putting it in distilled water. The cells open as if by enchantment, the pollen-grains are readily detached, the alcohol dissipates the air-bubbles, and by this process a much larger portion of the anthers can be obtained for examination.

Herpell's Method of Preparing Fungi for the Herbarium.†—G. Herpell announces some improvements on his method previously published, and which we have already described.‡

In the method proposed for the preservation of the fleshy parts he has no improvement to suggest; but in the preparation of the spores various slight emendations have presented themselves.

* Bull. Soc. Belg. Micr., vii. (1881) pp. cxliv–v.
† SB. Bot. Ver. Prov. Brandenburg, June 24, 1881.
‡ See this Journal, i. (1881) p. 136.

The fixing of the coloured spores with lac on white paper answers completely; but, in the case of the Leucospori, only those of species of *Russula* and *Lactarius* unite firmly with the resin of the lac. On the other hand, the mode of fixing the white spores on blue cardboard simply with gelatine appears to answer in all cases; but the solution should be somewhat more dilute than previously stated. The best fluid is a warm solution of 1 part gelatine in a mixture of 150 parts water and 150 parts alcohol. This answers with species of *Russula* and *Lactarius*, while with *Agaricus* (*Collybia*) *radicatus* so concentrated a solution as 1 part gelatine in 30 parts water is necessary. The writer gives a list of a number of species, with the strength of solution required in each case. Some spores can be fixed on blue cardboard by the use of pure water only. In some cases, again, it is necessary to heat the solution strongly. *Agaricus* (*Collybia*) *maculatus*, *A.* (*C.*) *velutipes*, and *Marasimus peronatus* require a different treatment, which is described.

The author found the same results with the fluid recommended by Patouillard (2 parts mastic in 15 parts ether) as with the lac; the resin does not in all cases combine well with the white spores. The ether has some advantages in penetrating the paper more rapidly and completely, but, on the whole, Herpell prefers the use of alcohol.

Dissociation of Gland-Elements.*—Cauderau finds boiling the mucous membrane of the stomach in a solution of nitrate of soda a very good process for isolating the glands and gland-elements, but the constituent parts of the tissues become too brittle. This defect can be obviated by a previous immersion of some minutes in osmic acid. The cells will then remain admirably preserved after boiling for three hours, but can scarcely be stained at all. The following combination is therefore recommended:—One part of Müller's fluid is diluted with two parts of water and about 30 to 40 grammes of the sodic nitrate is dissolved in a litre of the mixture. Boiling for three hours in this compound is sufficient to break up the mucous membrane of the stomach. The maceration, besides acting on the glands, extends to the muscular coat.

Method of Preparing and Mounting Soft Tissues.†—The conclusions arrived at with regard to the structure of the nervous centres by means of the successive action of bichromate of potash and nitrate of silver will certainly receive confirmation from this method, which we owe to Professor C. Golgi. It has the double advantage of enabling us to stain the nerve-cells black within a given time, and of turning out preparations which may be kept for a long period in the ordinary mounting media.

The pieces of tissue are hardened to the necessary degree in Müller's fluid, or in solutions of bichromate of potash, whose strength

* Gaz. méd. de Paris, No. 45, pp. 577–8. Cf. Jahresber. Anat. u. Physiol., viii. pp. 13–14.

† Rendiconti R. Istit. Lombard., xii. pp. 206–10. Cf. Jahresber. Anat. u. Physiol., viii. pp. 12–13.

is gradually increased from 1 to $2\frac{1}{2}$ per cent. The pieces must not be more than 1 to 2 cm. thick, a large proportion of fluid must be used, and it must be frequently changed. In from 15 to 20 days the pieces are put into corrosive sublimate solution $\frac{1}{4}$ to $\frac{1}{2}$ per cent. in strength. The reaction requires at least 8 to 10 days, and during this time the liquid must be daily renewed. The pieces gradually change colour and acquire the appearance of fresh brain-substance. They may be allowed to remain even for a longer time in the solution, which serves at the same time to harden them. Sections which are to be kept must be repeatedly washed, else crystals and other deposits appear upon them and alter the appearance under the Microscope. They keep admirably well in glycerine, which is perhaps better for the purpose than Canada balsam and dammar. By this method the ganglion-cells with their processes are acted upon; their nuclei are often left visible; the elementary constituents of the walls of the vessels, and especially the smooth muscular fibres (muscle fibre-cells), are also brought out. Golgi reports having had good results from the application of this treatment to the cortex of the cerebrum, negative results in the case of the spinal cord, and but slight success with the cerebellum. The author calls the reaction an *apparently black* one, inasmuch as the elements on which it has taken effect appear white under surface illumination, and black only by transmitted light.

Preservation of Anatomical Specimens.*— L. Gerlach recommends the glycerine process of Van Vetter, which has been somewhat modified, firstly by Stieda and then by Gerlach himself. Stieda's recipe is as follows:—Make a mixture of 6 parts of glycerine, 1 of brown sugar, and $\frac{1}{2}$ part of saltpetre; Gerlach uses 12 instead of 6 parts of glycerine. The preparations are cleaned and laid in this liquid, in which they remain from three to six weeks, according to their size. When taken out they have a dark-brown colour and are quite firm; they are then hung up in a chamber of the temperature of 12°–14° R. (59° to $63\frac{1}{2}$° Fahr.). In the course of eight to ten days they become soft and flexible, but must be allowed to hang from two to six months longer, to be available for demonstrations. The more glycerine used, the lighter in colour the preparations remain. The method is best applied to preparations of articulations, to sense organs (eye, ear), larynx, &c. The formation of a crystalline precipitate, which sometimes appears in the drying, is met by the increase in the proportion of glycerine and a diminution of the saltpetre and sugar. If large objects are to be set up, such as whole extremities with their muscles, or the thorax with the ligaments dissected, pure glycerine is preferable to the cheap crude article, for specimens turn out whiter and less hard in it. Gerlach has used it for temporal bone with tympanum and auditory ossicles, and obtained valuable preparations which may be employed with great success to demonstrate the transmission of waves of sound from the tympanum to the labyrinth.

Barff's Preservative for Organic Substances.—A new preservative applicable to all animal and vegetable substances has been

* SB. phys.-med. Soc. Erlangen, July 28, 1879. Cf. Jahresber. Anat. u. Physiol., viii. pp. 112–13, and Jahresber. (Virchow and Hirsch) for 1879, p. 2.

patented by Professor F. S. Barff. It is a compound prepared by mixing boracic acid with glycerine. The former is dissolved in the latter by the aid of heat, the solution taking about four or five hours, care being taken, however, that the temperature employed shall not be so excessive as to decompose the glycerine. To such solution or compound a further quantity of boracic acid is added from time to time until the boracic acid ceases to be dissolved. The compound resulting when allowed to cool, is solid, and is called by the patentee boroglyceride.

In order to employ the compound, a solution is prepared in water, alcohol, or other suitable solvent, and the organic substances to be operated upon, either immersed in or impregnated with such solutions. Solutions may be prepared of various degrees of strength; but Professor Barff finds that a solution consisting of about one part by weight of the compound and forty parts by weight of water will give good results; other proportions may, however, be adopted for special purposes. Solutions of the compound may be applied to the preservation of all organic substances either animal or vegetable.

Injection-mass.*—L. Teichmann injects blood-vessels and lymphatic vessels with a mass which is fluid when cold; it is made with finely powdered materials and linseed-oil varnish up to the consistency of putty, and altered to that of honey or syrup as required, by volatile liquids (such as ether and carbon disulphide). Prepared chalk, zinc white, &c., may be used, coloured with cinnabar, ultramarine, chrome yellow, &c. Ordinary hand-pressure is not powerful enough, so Teichmann makes use of syringes, such as those for injecting gutta-percha, in which the piston is impelled by a screw arrangement.

In this way, even the finest and most elaborate ramifications of the vessels may be readily and with certainty filled. The mass soon stiffens, partly owing to transudation, partly to evaporation of the ether, so that it does not ooze from vessels which may be cut through; it remains soft for a certain time and is as hard as stone when the preparation is finished. The advantages of this method are obvious.

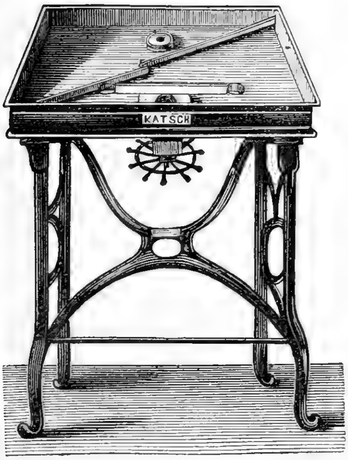
Imbedding Delicate Organs.†—L. Frédéricq describes a method by which pieces of tissue or organs, such as brains of small animals, livers, kidneys, &c., are so thoroughly impregnated with paraffin that they retain a firm consistence, do not shrink up, and keep as well as the best casts of the organs. The tissue or organ is hardened by placing in alcohol, first dilute, then absolute, for several days, is then laid for several days in oil of turpentine, until transparent, when it is transferred to paraffin melted in a water bath, and kept there at a temperature of about 55° C. (it must not exceed 60°), for from two to eight hours, according to the size of the object. It is removed and dried while hot in a current of steam, by blotting-paper or otherwise, and finally allowed to cool.

* SB. Math. Kl. Krakau. Akad., vii. pp. 108–58. Cf. Jahresber. (Virchow and Hirsch) for 1879, p. 2.

† Gaz. méd. de Paris, 1879, No. 4, pp. 45–6. Cf. Jahresber. Anat. u. Physiol., viii. p. 12.

Katsch's Large Microtome.*—In this instrument (Fig. 25), a stand, similar to that of a sewing-machine, supports a tray, across which, in a diagonal direction, a small ledge is fixed. This is inclined rather outwards, and on one end of it the cutting knife rests, so as to move steadily against the microtome plate which rises a little above the tray, and surrounds the preparation. The plate itself is at the end of a hollow cylinder fixed to the tray, in which a massive metal cylinder can be raised and lowered by a screw underneath. There are three knobs on the upper part of this cylinder to fix the substance in which the preparation is imbedded.

Fig. 25.



When the latter is cooled (which is done by pouring water into the tray) the section can be made.

A special advantage of this form of instrument is that sections can be cut under water, and that the screw may be fixed by means of a small click to the $\frac{1}{5000}$ mm. In turning the screw the click is caught at every $\frac{1}{5000}$ mm., and gives an audible signal.

Cox's "Simple Section-cutter for Beginners."†—In this, economy and simplicity have been carried to at least their furthest practicable limits, as the basis of the instrument is a sewing-machine cotton-reel, and a Perry's music binder. The cost does not exceed 2 or 3 pence.

Cutting Sections of very small Objects.‡—H. Strasser adds from 3 to 4 parts of tallow to the imbedding mixture recommended by Kleinenberg (spermaceti 4 parts, castor-oil 1 part), and in order to be able conveniently to arrange very small objects for cutting sections in any required position, he places them in the mass while this is still warm, between plates of mica; the temperature must never exceed 45° C. After cooling the mica plates may be readily separated from the mass, which has the form of a thin sheet, and contains the object; it may be then fixed with heated pins in the desired position upon a block of a substance not easily melted.

Mounting in Balsam.§—Dr. C. Seiler, in a paper contrasting glycerine and balsam as mounting materials, gives the following as a desirable modification of the old process of mounting in various

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 96–7 (1 fig.).
† Ann. Rep. Postal Micr. Soc., 1881, pp. 12–13 (1 fig.)
‡ Morphol. Jahrbuch, v. (1879) p. 243. Cf. Zool. Jahresber. Naples, i. (for 1879) p. 35.
§ Proc. Amer. Soc. Micr., 1881, pp. 60–2.

media, whereby the disadvantages attendant upon the use of balsam are removed, so that it becomes the preferable method.

Take a clear sample of Canada balsam and evaporate it in a water or sand bath to dryness; i.e. until it becomes brittle and resinous when cold. Dissolve this while warm in warm *absolute* alcohol (Squibbs'), and filter through absorbent cotton. Place the section, after it has been stained, in weak alcohol (about ·60), and allow it to remain in a few minutes, then transfer it to ·80, ·95, and finally to absolute alcohol, in which it should remain a few minutes also. Then transfer it to the slide (which has been slightly warmed above a spirit-lamp so as to remove all moisture), drain off all superfluous alcohol, and place a drop of the alcoholic balsam solution on the specimen. In a few seconds the latter will become transparent, when it may be covered, and set aside to dry. In damp weather, or when breathed upon, a milky edge will be noticed on the drop of balsam, which is caused by minute globules of water, which, however, may readily be dispelled by the application of a little heat to the under side of the slide. It will be seen that by the *gradual* dehydration of the specimen, the danger of distortion of the histological elements is materially diminished; that by the omission of any clearing agent the shrivelling is avoided as well as the solution of fat in the cells prevented, for cold alcohol alone will not dissolve fat; and finally by evaporating the balsam to dryness all other constituents except the pure balsam are driven off, so that the danger of crystallization is avoided.

Mounting in Glycerine.*—Dr. S. R. Holdsworth finds the following plan to be efficacious in avoiding the difficulty found in getting rid of the surplus glycerine when it has passed beyond the cover-glass. He puts a very small drop of glycerine upon the object, just sufficient that when the cover-glass is applied it will not extend to the margin. A solution of Canada balsam in chloroform or benzoline is then run in to fix the cover-glass, and not being miscible with the glycerine, an air-space is formed between the two fluids which has not been found to be detrimental. The slide can be finished with a ring of balsam or other cement.

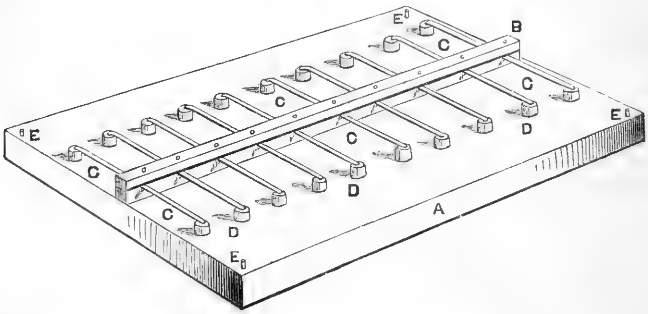
Smith's Slides.†—The Editor of the 'American Monthly Microscopical Journal' writes:—"Mr. J. Lees Smith, of this city, has prepared some very attractive slides in this manner: the glass slips are first coated with photographer's 'granite varnish' by flowing, just as a plate is coated with collodion in photography. This coating of varnish gives the slide the appearance of finely ground glass. It is then placed on the turntable, and, by means of a knife-blade, the varnish is entirely removed from a circular spot in the centre, just large enough for the cell in which the mount is to be preserved. The preparations we saw were mounted in glycerine, and the clear and transparent cells were made of Brown's rubber cement, which Mr. Smith regards as a most excellent cement, especially for glycerine

* Ann. Rep. Postal Micr. Soc., 1881, p. 11.
† Amer. Mon. Micr. Journ., ii. (1881) p. 179.

mounts. Imagine a slip of ground glass with a transparent spot in the centre, upon which objects can be mounted, and one can thus form an idea of the appearance of these slides."

Spring Clip Board.*—Mr. W. Stringfield gives the accompanying sketch (Fig. 26) of the spring clip boards he has had in use for some time, and which, for reducing the breakage of thin glass covers to a minimum, economy of construction, and convenience of moving, far

FIG. 26.



surpass, he considers, any arrangement that has come under his notice. They are made of mahogany, but of course pine or other wood can be used. All, however, should be baked previously to finally planing up. A is a piece of mahogany $12 \times 7\frac{3}{4} \times \frac{3}{4}$ inches; B two strips, each securely fastened down the centre of the base board A by eleven screws; C C pieces of watch or crinoline steel, $3\frac{3}{4}$ inches long, $\frac{3}{8}$ inch wide, with a hole punched in either end to allow of a small brass pin passing through for securing the pressers; D D small pieces of phial corks; E E E E four screws fitting in corresponding holes drilled in the bottom of each board, thus allowing a number to be placed one on the other without injury to the slides, and admitting a free current of air.

Examination of Living Cartilage.†—J. M. Prudden found the episternum of the frog, especially of *Rana temporaria*, an extremely good object in which to examine cartilage in the living animal. A moderately curarized frog should be taken, and an incision made in the skin from the lower jaw to the middle of the sternum, and then two cross cuts; the operator must turn back the edges of the skin, and divide the submaxillary muscle, thus exposed, near the middle, avoiding the large veins which pass inwards over the apex of the episternum. The latter lies at the bottom of the incision, being covered only by a somewhat loose connective tissue. If the delicate laminæ of connective tissue between the episternum and hyoid bone are now cut through, and the head turned back at right angles to the body, the episternum is extruded from the wound, projects forwards,

* Sci.-Gossip, 1881, p. 232 (1 fig.)

† Virchow's Archiv, lxxv. pp. 185–98. Cf. Jahresber. Anat. u. Physiol., viii. pp. 11–12.

and may be rendered accessible even to strong magnifying powers if placed on a glass block of suitable size. For prolonged observations the whole object may be attached to Thomas's object-holder, with arrangement for irrigation, and may be kept in the natural fresh condition of life by irrigating with amniotic fluid or $\frac{1}{2}$ per cent. salt solution.

By this method Prudden was able, by irrigating with the latter fluid, to observe the cartilage cells in the episternum of the frog for many hours, in the living and fresh condition. Under these circumstances the intercellular substance appears homogeneous, the outline of the cell is very clear, and the cell-protoplasm has a finely granular appearance, with bright globules near the nucleus; the latter has a double contour, is penetrated internally by a number of fine lines, which meet at broader internodes. In this form of nucleus he could observe phenomena of movement, but could not determine that any effect was produced upon these movements by weak chemical reagents, by heat, or by electric currents. Under the action of 1 to 3 per cent. salt solution the cells shrink back from their walls, and are seen to be provided with numerous processes, which radiate to the walls of the cavities; vacuoles are also formed in the interior of the cells under these circumstances. When water is added to the solution, the cells resume their original appearance. Similar production of vacuoles under pathological conditions in cells, which have in like manner the power of reverting to the normal condition (Swetsky), the author believes to be explicable by an increase in the density of the liquid which the tissues contain. If the living episternum is irrigated with indifferent liquids and then replaced, the cells appear quite unaltered at the end of nine weeks.

In an episternum which had been excised and placed in the lymph sac of a frog, the cells were found to be filled with yellow drops, soluble in ether, after five days, and the cell-nuclei stained with carmine. An identical degeneration of the cells, accompanied by susceptibility to staining with carmine, took place when the episternum was exposed and replaced after its cells had been killed by chemical reagents or electric shocks. Carmine did not stain the nuclei at all in the living cartilage, neither after irrigation with 2 per cent. salt solution, nor after subsequent dilution of this liquid with water, nor when the episternum had been restored to the body for some weeks; consequently the cells had not died. The author found that even very weak solutions of iodine, and also carbolic acid solutions of a greater strength than $\frac{1}{4}$ per cent.—that is, solutions which are actually employed in the treatment of affections of the joints—caused the immediate death of the cells, so that when the tissue was subsequently replaced the degenerative processes just mentioned set in. The author found that the cells of living cartilage collapsed under a temperature of 53° C., in detached pieces at that of 50° C., a lower temperature than that which Rollet found necessary.

Statoblasts of Lophopus crystallinus as a Test for High-power Objectives.—Areolations of Isthmia nervosa.—Dr. John Anthony writes:—"I forward an object which I think will be found of value as a test for high-power objectives, and which, not being a diatom or very diaphanous, needs rather the quality of 'resolution' than that of 'definition' to deal with it satisfactorily. I take it that a 'test' to be of use should be fairly easily obtainable; that the specimens should, from the nature of the structure, be uniform; and that to merit the name of a 'test' it should not be *too* easily made out, even by the best modern glasses.

"I am sanguine enough to think that the statoblast of *Lophopus crystallinus*, which is easily procurable in any numbers, will be found to meet these conditions. The difficult part is the structure of the membrane, which seems to be stretched over the coarse hexagonal framework of the statoblast. I have seen it well, but it tried my fine $\frac{1}{25}$ of Tolles, and was most bright and clear with an excellent $\frac{1}{10}$ homogeneous-immersion objective, which Mr. Tolles has just sent to me. I found the more axial the illumination the better—obliquity was fatal. I used a cap on my condenser of $\frac{3}{16}$, the diameter of condenser being $\frac{1}{4}$, and it evidently aided the definition.

"While on high-power testing, let me say that the hexagonal areolations seen in the apparent openings in *Isthmia nervosa* are valuable for trying the qualities of $\frac{1}{8}$, $\frac{1}{10}$, and $\frac{1}{16}$ or more. The areolations are not small, but so delicate as not to be seen at all by a poor object-glass, while the better the quality of objective the more clearly can they be made out, till they look like delicate network. I mention this because I find the existence of this delicate structure is not generally known; though I have used it for some years to try the quality of objectives."

Microscopical Structure of Malleable Metals.*—The following observations have been made by Mr. J. V. Elsden on the minute structure of metals which have been hammered into thin leaves. Notwithstanding the great opacity of metals, it is quite possible to procure, by chemical means, metallic leaves sufficiently thin to examine beneath the Microscope, by transmitted light. Silver leaf, for instance, when mounted upon a glass slip and immersed for a short time in a solution of potassium cyanide, perchloride of iron, or iron-alum, becomes reduced in thickness to any required extent. The structure of silver leaf may also be conveniently examined by converting it into a transparent salt by the action upon it of chlorine, iodine, or bromine. Similar suitable means may also be found for rendering more or less transparent most of the other metals which can be obtained in leaf.

An examination of such metallic sections will show two principal types of structure, one being essentially granular, and the other fibrous.

The granular metals, of which tin may be taken as an example, present the appearance of exceedingly minute grains, each one being perfectly isolated from its neighbours by still smaller interspaces. The cohesion of such leaves is very small.

The fibrous metals, on the other hand, such as silver and gold, have a very marked structure. Silver, especially, has the appearance

* 'Nature,' xxiii. (1881) p. 391.

of a mass of fine, elongated fibres, which are matted and interlaced in a manner which very much resembles hair. In gold, this fibrous structure, although present, is far less marked. The influence of extreme pressure upon gold and silver seems to be, therefore, to develope a definite internal structure. Gold and silver, in fact, appear to behave in some respects like plastic bodies. When forced to spread out in the direction of least resistance their molecules do not move uniformly, but neighbouring molecules, having different velocities, glide over one another, causing a pronounced arrangement of particles in straight lines.

This development of a fibrous structure, by means of pressure, in a homogeneous substance like silver, is an interesting lesson in experimental geology, which may serve to illustrate the probable origin of the fibrous structure of the comparatively homogeneous limestones of the Pyrenees, Scotland, and the Tyrol.

Sections of Fossil Coniferous Woods.—Voigt and Hochgesang of Göttingen have issued (price 65 marks) a collection of seventy microscopic slides of coniferous woods, fossil and recent, prepared by Professor Göppert. The present collection is a first instalment only, and is devoted to the Araucarieæ. Where possible, each species is represented by three sections, one transverse, the second central or radial, and the third cortical or tangential. Sections of recent woods are placed side by side with those of the most nearly allied fossil woods; as sections of an *Araucaria* (*A. Cunninghami*) and of a *Dammara* (*D. australis*) by the side of the fossil *Araucarites*. The preparations are arranged in a polished mahogany box with ledges, and have been made on slides of white glass 50 × 33 mm., and 1·5 mm. thick, with polished edges, under square cover-glasses of 18 mm. length and breadth, in Canada balsam. Only those of the recent Araucarieæ are under round cover-glasses of 20 mm. diam. in glycerine. The sections have been made with the greatest care and skill. Instead of the ordinary length of about 4 mm., these are of double or treble that length, so as to render possible a more complete examination. Special care has been taken to furnish sections which illustrate the nature of the process of petrifaction.

Aeration of Laboratory Marine Aquaria.*—The plan shown in Fig. 27 is recommended by M. Kunckel d'Herculais for aerating a salt-water aquarium by means of a fall of fresh water.

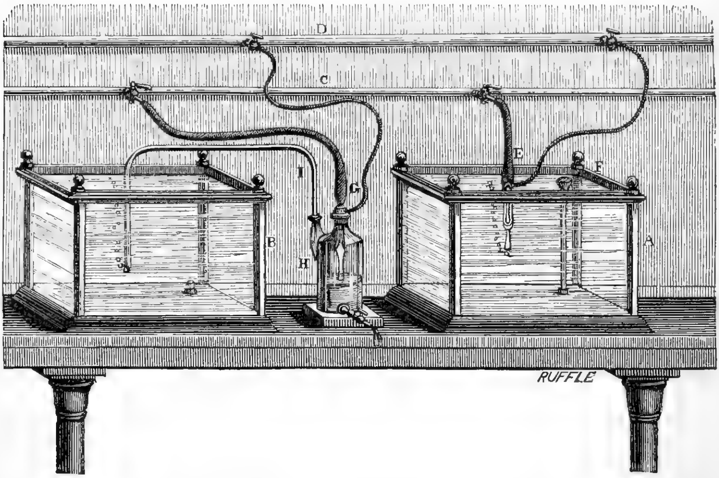
The figure shows two aquaria, A being fresh-water and B salt-water. In the first case the process is of course very simple, the water from the pipe C passing down the tube E, air being obtained through the tube F and pipe D which communicates with the open air so as to prevent air being abstracted from the confined laboratory.

In the case of the salt-water aquarium B, the fresh-water passes from the pipe C down the tube G into the bottle H, with three openings, which holds about two litres, air being obtained as before from the open air through D and the tube shown on the right. A

* See 'Manuel de Zootomie,' par A. Mojsisovics, traduit par J. L. de Lanessan (8vo, Paris, 1881), pp. 61–6 (1 fig.).

third tube I conducts the air from the bottle to the aquarium, while the water escapes from the bottle through the tap at the bottom. All that is necessary is to regulate the flow into and out of the bottle in such a way that the water shall be at a constant level. When this has once been experimentally ascertained the aquarium may be left

Fig. 27.



without fear day and night. If the bottle were allowed to get empty the aeration would of course stop, while if it were filled the fresh water would pass into the aquarium. In order to supply the loss from evaporation a little fresh water should be added from time to time, which will prevent the necessity for renewing with salt water.

The apparatus will pass $22\frac{1}{2}$ litres of air per hour through an aquarium of 90 litres at an expenditure of water of 36 litres. In this case the exit tube for the air, 5 mm. in diameter, is plunged 11 cm. into the aquarium. If the tube is plunged lower, say 36 cm., the pressure of the water which obstructs the exit of the air is greater, and 45 litres of water would be expended in passing 16 litres of air, i. e. 9 litres of water more, and $6\frac{1}{2}$ litres of air less. In the author's opinion, apart from the increase in the expenditure of water, it is undesirable that the air tube should go to the bottom of the aquarium, as the disturbance to the water which is thus caused is unfavourable to the development of delicate animals.

To ensure that the air-bubbles shall be small, the air tube is terminated by a small sphere with half-a-dozen very small orifices at its equator, and enveloped with two or three thicknesses of muslin.

PROCEEDINGS OF THE SOCIETY.

Meeting of 14th December, 1881, 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 9th November last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donor.

	From
Micrographic Dictionary. 4th ed. Parts 4–6.	*Mr. Van Voorst.*

Mr. Crisp exhibited Parkes' Drawing-room Microscope with magnetic stage, and two bottles from Professor H. Van Heurck, of Antwerp, containing new fluids for use with homogeneous-immersion lenses; one ("liquide homogène à la tacamaque") with a refractive index of 1·510, and a dispersive power of ·0072, and the other ("à l'oliban) of the same index, but with a dispersive power of ·0077.

Mr. John Mayall, jun., exhibited Mr. Deby's method of turning the correction-collar of objectives, the chief peculiarity of which was, that the collar was worked by a tangent screw (with a long arm) acting upon a worm-wheel, instead of by the ordinary collar-adjustment, which Mr. Deby had found to be inconvenient (see p. 107). As at present made, it would not go into an ordinary box, but (as had been pointed out by Mr. Beck) the screw pinion might be considerably shortened, so as to admit of its being put in a box in the usual way.

Mr. Beck said that it must be borne in mind that in adjusting an object-glass it was often desirable to get a sudden adjustment, which could not be very well done with this form.

Mr. T. Charters White described, by means of black-board drawings, a new form of growing or circulation slide which he had recently devised, and exhibited the slide in action under a Microscope (see p. 19).

Mr. James Smith said he had been trying himself to work out some better form of growing-slide than those in common use, but his attempts had hitherto proved abortive. He was, however, very much pleased with the one now shown by Mr. White, the great advantage of which was its extreme simplicity, and its capability of keeping objects alive for any length of time.

The President thought that its only disadvantage would be that when carefully examining one particular individual, others might be introduced into the cell by the flowing water. With some kinds of organisms there would, of course, be no such danger, but it would hardly be safe with an *Amœba*, for instance. He had himself found, when studying the life-history of minute species, that it answered very well to make a small cell of ordinary thin glass, and by surrounding the whole with blotting-paper, kept constantly wet, he had been able to retain three or four monads of large size under constant observation for several weeks. A similar arrangement to that adopted by Mr. White had been used on the human body as a means of applying evaporating lotions.

Mr. J. W. Stephenson said he had brought for exhibition some scales of insects (*Machilis maritimus* and *Tomocertus* [*Podura*] *plumbea*), mounted in phosphorus, and shown under a $\frac{1}{25}$-inch objective with very oblique light and the binocular. They demonstrated that it was possible even with such a high power to get with the binocular a distinctly stereoscopic effect, and that when so seen a much more perfect idea of the structure of the scale could be obtained than was possible under the monocular. Although the structure of the scales of *Machilis maritimus* and *Tomocertus plumbea* is probably the same, they cannot be said to be "corrugated" in either case. In *Machilis* the appearance of the upper side is that of longitudinal semi-cylindrical grooves, which had been likened by a medical gentleman to a pill machine; whilst the latter, probably from being so much smaller, appears to have rectangular grooves, similar to those in a curry-comb, the back being in each case supported by slender transverse bars, which are approximately from one-third to one-half the distance apart of the longitudinal divisions.

Mr. Beck said that as to the Podura scale shown by Mr. Stephenson, what he described with respect to the structure of the scales was entirely opposed to what they had been shown to be. In such matters where high powers and oblique light were used, he thought it was very doubtful if they ought to believe what they saw, as they might so very easily be deceived by appearances. So far as he knew, no one had hitherto brought forward anything which would refute what he had shown some years ago, when he put moisture on one side of a scale, and found that it dried off quite flat, whilst if he put some on the other side, it ran up and down as if in corrugations. His brother also did the same kind of thing with a *Lepisma* scale and Canada balsam. Moisture, as they knew, would get into slides which were mounted dry, and the same appearances were presented there. Having kept the insects, and being able to tell which was the upper, and which the under side of the scale, and being also able to show these corrugations in a mechanical way, he could only say that even if the effect could be seen as described by Mr. Stephenson, he should not, he was afraid, be convinced, for he knew very well that in most cases, by reversing the shadows, they could reverse the appearances. If they wanted to determine the real structure with high powers, they must argue from analogy rather than from what they saw. They had compound substances to deal with, and effects were produced which had to be studied and analyzed and examined very carefully. Unless, therefore, any one could show upon the upper side what he had shown mechanically on the under side, he considered that the appearances obtained by simple vision were deceptive.

Mr. Stewart said he understood that some time since a microtome was made, so delicate in its adjustment as to be able to cut sections of a valve of a diatom. Could not this be made available for making sections of the scale which would show the configuration of it as conclusively as if done in the mechanical way?

Mr. Crisp said that the existence of such a microtome (cutting 150 consecutive sections of the brain of a cockroach) had been reported, and he had endeavoured to obtain it, but hitherto in vain. So far as he knew also, no results obtained from any actual sections had been published, other than those which appeared in the 'Archiv f. Mikr. Anat.' in 1870. The further and more recent series promised by Dr. L. Flögel * had not been heard of.

Mr. Stephenson said that notwithstanding Mr. Beck's remarks, he could not but feel clear as to its being the upper side of the scale on which these grooves were, for the pedicel or "quill" of the "feather," which is necessarily on the under side of the scale, was bent down from the plane of the scale, and the markings were clearly on the opposite side to that.

Dr. John Anthony's note was read by Mr. Stewart, suggesting the statoblasts of *Lophopus crystallinus* as a test for high powers (see p. 129). The difficult part was stated to be the structure of the membrane. The portions of the statoblasts referred to were drawn on the board and further explained by Mr. Stewart.

Mr. Guimaraens called attention to what appeared to be a male specimen of the *Echinorhynchus* of *Lota vulgaris* with ova in the interior, described as "dedans par hasard."

Mr. A. D. Michael read a paper, "Further Notes on British Oribatidæ" (see p. 1), which Professor Huxley and others state to be wholly viviparous. He found, however, that they are chiefly oviparous, as stated by Nicolet and others, and that the young are brought to maturity in, at least, four different modes:—1st. The egg is deposited in a slightly advanced stage, as in insects. 2nd. Deposited with the larva almost fully formed. 3rd. The female is occasionally viviparous (in these modes only one egg is usually ripe at a time). 4th. Several eggs are matured at once, but not deposited. The mother dies, the contents of her body, except the eggs, dry up, and her chitinous exterior skeleton forms a protection throughout the winter to the eggs. The occurrence of a deutovum stage in the egg is recorded, i. e. the egg has a hard shell which splits into two halves as the contents increase in volume, the lining membrane showing between, and gradually becoming the true exterior envelope of the

* See this Journal, i. (1881) p. 509.

egg. Several new and interesting species were described and figured, and exhibited under Microscopes.

The President said he was very glad that Mr. Michael did not form a new species from a single specimen. The history of the death of the parent insect before the escape of the ova was, he thought, very anomalous in nature; indeed, he did not remember anything at all like it. Many of the Lepidoptera died very soon after the eggs were laid, but he knew of no case in which this remarkable circumstance had been observed.

Mr. Stewart did not remember any in which the eggs were retained in the body of the dead mother, but in the case of the *Coccus* there was something, perhaps, a little like it, the mother dying immediately after the deposition of the eggs, and forming a sort of roof over them with her dead body, which served to protect them during the winter.

Mr. J. W. Stephenson exhibited *Pleurosigma formosum* mounted in a solution of biniodide of mercury and iodide of potassium, a mounting fluid which, with the exception of solution of phosphorus, had a higher refractive index than anything known to him. It had been used by Mr. Browning for prisms, and had an index of 1·68. The index of bisulphide of carbon was 1·624, of monobromide of naphthaline, 1·658, and of sulphur, 1·662, so that the biniodide of mercury was ·056 higher than bisulphide of carbon. Mr. Browning found that the best means of sealing it was by using white wax. He had brought some of it to the meeting as a sample. Being an aqueous fluid appeared to be a great advantage, and it could be used of any strength from 1·33 to 1·68.

The President said he had had his eyes opened to the value of this solution as a highly refractive medium, but had been disappointed by being told that it was only useful for purposes of spectrum analysis, in consequence of the great effect which it had on the red rays.

Mr. Stephenson did not know how far its great dispersive power would be prejudicial, but he had tried it for mounting, and found that it did very well for diatoms.

Mr. Symons read a paper on "A Hot or Cold Stage for the Microscope" (see p. 21), the details of which were drawn upon the board and the apparatus itself exhibited.

The President inquired if Mr. Symons had used this stage for observing the motion of the white blood-corpuscles. He also suggested that the brass would be better if it came rather more flush with the plate.

Mr. Symons had not examined corpuscles with the stage, having hitherto only applied it to ascertaining the melting-points of various substances. He thought there would be no difficulty in using high powers with it, as the objective could be brought into actual contact with the glass if desired, the only thing between the plate and the objective being the thin glass.

The following Instruments, Objects, &c., were exhibited :—

Mr. Crisp :—Parkes's "Drawing-room" Microscope with magnetic stage.

Mr. Deby :—New method of moving the correction-collar of objectives (see p. 107).

Mr. Guimaraens :—Echinorhynchus of *Lota vulgaris.*

Mr. Michael :—*Cepheus ocellatus* n. sp. Nymph—showing the eye-like appearance of the stigmata and stigmatic organs. *Damæus monilipes* n. sp.—showing the tibiæ of the first pair of legs. *Leiosoma palmacinctum*—internymphal ecdysis showing arrangement of the palmate hairs on new skin forming within present one. *Notaspis licnophorus* n. sp.—showing the stigmatic organs.

Mr. Stephenson :—Scales of *Machilis maritimus* and *Tomocertus* (*Podura*) *plumbea*, mounted in phosphorus under $\frac{1}{25}$-inch objective and binocular (see p. 134).

Mr. T. C. White :—New form of Growing or Circulation slide (see p. 19).

New Fellows.—The following were elected *Ordinary* Fellows :—Messrs. William Blackburn, Walter H. Coffin, F.L.S., F.C.S., the Hon. William Nassau Jocelyn, and Theodore Wright.

Conversazione.

The first Conversazione of the Session was held on the 7th December last in the Libraries of King's College.

The following were the objects, &c., exhibited :—

Mr. C. Baker :

- Stephenson's Erecting Binocular Microscope for Laboratory use.
- Homogeneous-immersion and Glycerine-immersion Objectives by Gundlach and Zeiss.
- Abbe's Apertometer and Immersion Illuminator.
- Dissecting Microscope by Zeiss.

Dr. Beale :

- Muscular fibres of the bladder of *Hyla.*
- Nerve-fibres of ditto.
- Capillaries and nerve-fibres of the palate of the common frog.

Messrs. R. and J. Beck :

- *Pleurosigma angulatum* with their new $\frac{1}{6}$ object-glass.

Mr. W. A. Bevington :

- *Isthmia nervosa* in situ.

Mr. W. G. Cocks :

- *Ophrydium* and a remarkably large form of *Epistylis.*

Mr. J. E. Creese :

- Radiolarian ooze from the 'Challenger' Expedition (2600 fathoms).

Mr. Crisp :

- Colouring matter from willow-tree Aphides (*Lachnus viminalis*), polarized, showing the characteristics of Salicine. Prepared by Mr. C. J. Muller in illustration of his paper (*ante*, p. 39).

Mr. T. Curties:
Schizonema Grevillei in situ.

Mr. L. Dreyfus:
Spirorbis nautiloides from a shell.

Professor P. M. Duncan:
Sphæridia from a Spatangoid.
Cliona from a coral.

Mr. F. Enock:
Battledore fly (*Mymar pulchellus*).
Eyes of spider (*Salticus tardigradus*).

Mr. F. Fitch:
Dissection of blow-fly, showing abnormal condition of sucking stomach.

Mr. C. J. Fox:
Various diffraction effects produced by rectilinear and circular gratings.

Mr. D. W. Greenhough:
Crystals of asparagine.

Mr. J. F. Gibson:
Collection of seeds of British flowering plants.

Mr. W. H. Gilburt:
Section of Sporangium of *Equisetum limosum*, showing division of nuclei in spore-mother-cells.

Dr. Heneage Gibbs:
Bacteria in kidney.

Mr. J. W. Groves:
Lymphatics in web of frog's foot injected with silver nitrate.
Transverse section of stem of *Smilax officinalis* stained with magenta, iodine green, and Nicholson's blue.

Mr. A. de Souza Guimaraens:
Diplozoon paradoxum from carp.

Mr. H. F. Hailes:
Dactylopora and other Foraminifera from the Paris basin.

Mr. J. Hood:
Coccochloris cystifera and some Rotifers.

Messrs. Hopkin and Williams:
A large specimen of bichromate of potash crystals (14 lbs.).

Mr. J. Hunter:
Upper and lower jaw of cat, &c., with Polariscope.

Mr. J. E. Ingpen:
Illustrations of Professor Abbe's diffraction experiments.

Mr. W. Joshua:
Desmids of many species from North Wales and other places.
Œdogonium Wolleanum Wittr. *β insigne* Nordst. Stromsberg, Sweden. *Ex Herb. Dr. Otto Nordstedt.*
Œ. Wolleanum Wittr. in Rab. Alg. Eur. No. 2547. Exs. Wittr. & Nordst. Alg. aq. dulc. exsic. fasc. 3, No. 107. This species has its place between *Œ. Borisianum* (Le Cl.) Wittr. and *Œ. concatenatum* (Hass) Wittr., but is well distinguished from both; among other things through the fact that the effect

of the fecundation extends not only to the oosphere but also to the wall of the oogonium. This wall increases in thickness after the fecundation, receiving at the same time longitudinal costæ on its inner side.

Mr. A. D. Michael:

A new species of *Hypopus*.

Eremeus cymba, one of the rarest of the British Oribatidæ.

Dr. Matthews:

Corticium abyssi, and other sponges.

Dr. Millar:

Bacteria which convert nitrites into nitrates.

Mr. Millett:

A species of *Acetabularia* from the Lagunes near Cette.

Mr. E. M. Nelson:

Nobert's 19th band (112,595 lines to the inch), with Powell and Lealand's oil-immersion $\frac{1}{12}$ (N.A. 1·428), and their vertical illuminator (× 1000 diameters).

Pleurosigma formosum, in balsam. Showing the sieve-like structure, with Zeiss's D D ($\frac{1}{6}$) objective (N.A. ·81), and direct light from Powell and Lealand's achromatic condenser (× 950 diameters).

Micrococcus in balsam, showing flagellum (length $\frac{1}{13340}$ of an inch), with Powell and Lealand's oil-immersion $\frac{1}{25}$ (N.A. 1·237), and direct light with achromatic condenser (× 1250 diameters).

Lieut.-Colonel O'Hara:

Crystals in poison of *Bungarus ceruleus*, an Indian snake.

New genus of Homoptera (Colydiidæ) from ant's nest in India.

Messrs. Powell and Lealand:

Amphipleura pellucida in phosphorus, with an oil-immersion $\frac{1}{8}$ (N.A. 1·47).

Mr. B. W. Priest:

Diastopora obelia.

Mr. S. O. Ridley:

Vertical sections of *Halichondria panicea* Johnston (Crumb-of-bread Sponge), prepared by the method adopted by Professor F. E. Schulze for *Euplectella aspergillum* (Trans. R. Soc. Edinburgh, xxix., ii., p. 661).

Mr. J. Smith:

Pleurosigma formosum and *P. angulatum*, with $\frac{1}{16}$ immersion-objective.

Mr. George Smith:

Dolerite from Liassic strata, Portrush, Co. Antrim, &c.

Mr. J. W. Stephenson:

Surirella gemma in phosphorus, with catoptric illuminator and Zeiss' homogeneous $\frac{1}{8}$.

Mr. C. Stewart:

Water spider imbedded in the nacreous layer of an *Anodon*.

Young sole.

Mr. W. H. Symons:
Fatty acids melting and congealing on new hot and cold stage.
Mr. C. Tyler:
Hyalonema mirabilis, &c.
Mr. H. J. Waddington:
Pseudomorphs. Copper. Copper formate reduced by heat. The resulting copper retaining the forms of the original crystals, and analytic crystals of magnesium platino-cyanide polarized with one prism.
Mr. F. H. Ward:
Section of stem of *Nymphæa alba, Rosa canina, Eucalyptus globulus*, &c., double stained.
Mr. C. White:
Corethra plumicornis.
Pellets of *Melicerta* showing them to be apparently hollow.
Messrs. Watson & Sons:
Pleurosigma formosum with large angle $\frac{1}{4}$, and *P. angulatum* with $\frac{1}{8}$ objective and Crossley's swinging tail-piece Microscope.

MEETING OF 11TH JANUARY, 1882, 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 14th December last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Davies, G. E.—Practical Microscopy, viii. and 335 pp., 1 pl. and 257 figs. (8vo, London, 1882)	*The Author.*
Retzius, G.—Das Gehörorgan der Wirbelthiere. I. Das Gehörorgan der Fische und Amphibien. 222 pp., 35 pls. (Fol. Stockholm, 1881)	*Ditto.*
Micrographic Dictionary, 4th ed., Part 7	*Mr. Van Voorst.*
Eupodiscus argus mounted in gum-juniper	*Mr. F. Kitton.*

The President called the special attention of the meeting to Prof. Retzius' work as one of exceptional excellence, and constituting a very handsome donation.

Mr. Badcock and Mr. Butler were appointed Auditors to audit the Treasurer's accounts.

The List of Fellows to be recommended to the Society for election as Members of the Council at the ensuing annual meeting in February, was read in accordance with the 44th Bye-law.

The President gave notice that at the next meeting an alteration would be proposed in the Bye-law relating to the payment of subscriptions, so that Fellows elected in any month after February would only be called upon to pay a proportionate part of the subscription.

Mr. Crisp exhibited Beck's Miner's Binocular Microscope, intended for rough use in the field, and a photograph by Mr. Jennings of ·001 grains of arsenic × 400.

Mr. Beck exhibited and described a new achromatic condenser for dry and immersion objectives, with five different front lenses set in a drum capable of being rotated consecutively over the back combination, and giving apertures from 7° in air to 110° in glass (1·25 N.A.). Mr. Beck stated that the mode of setting the front lenses avoided the inconvenience of having the immersion medium drawn away by capillary attraction, as would be the case if the lenses were mounted on a flat surface, as in previous forms.

Mr. Stewart exhibited and described a specimen of Gregarinidæ, from the vesiculæ seminales of the earth-worm, and explained their mode of growth and development, calling attention to the spines frequently observed upon them, and which he inclined to believe were *bonâ fide* cuticular appendages.

Mr. J. W. Stephenson read a paper "On Mounting Objects in Phosphorus, and in a solution of biniodide of mercury and iodide of potassium," in which he explained in detail the methods which he had found the most successful for the purpose.

Mr. Stewart thought that the biniodide would prove of very great value as a mounting medium, on account of another of its qualities not alluded to in the paper, namely, its chemical properties as an antiseptic. He believed he was correct in saying that it possessed the valuable power of preserving the colours of many delicate vegetable tissues, and that chlorophyll was not changed by it; blues would be found to fade a little, but red was kept well, and he thought that the fluid promised to be of great value in mounting such organisms as desmids, the beauty of which was so greatly increased by seeing them in their natural green colour.

The President said it occurred to him that these fluids might be also of great use in enabling any one to see other difficult objects, such, for instance, as coccoliths; they were very difficult to see in the ordinary way, and he would suggest to Mr. Stephenson to try whether they might not be made out more easily by means of such media as he had described.

Mr. Crisp read a paper "On the conditions for Utilizing the Full Aperture of Wide-angled Immersion Objectives."

Mr. Forrest's Compressorium (received 31st October last and accidentally mislaid) was exhibited and described. It is designed with a view to cheapness, and differs from the Wenham compressorium in the action of the spring and screw being reversed, so that instead of the spring putting on the pressure and the screw releasing it, the screw puts the pressure on and the spring releases it. It is claimed that this in practice will be found an advantage as it enables the observer to feel what pressure is put on.

Mr. Crisp referred to the erroneous statements that had been made as to the supposed advantages of Mauler's blue glass slides in "shortening the wave-lengths and so giving increased resolving power." The fact was that they were intended to be used with objectives affected with chromatic aberration, the performance of which was thereby greatly improved. A letter from M. Mauler was read to the meeting, in which he mentioned that the blue mounts would be found useful in the case of delicate histological preparations. They also agreeably modified the ordinary yellow light of gas and oil lamps.

Mr. Kitton's note on the use of gum-juniper for mounting diatoms was read. It has an index intermediate between water and balsam, and is soluble in methylated spirit. Preparations may be at once transferred from the spirit to the dissolved gum.

Dr. Anthony's paper "On the Threads of Spiders' Webs" was read by Mr. Stewart, enlarged copies of the illustrations being drawn upon the black-board.

The President said that Dr. Anthony had certainly exercised great ingenuity in his methods of procedure. He believed that the nature of the thread depended upon the spinnerets which were used.

Mr. James Smith said that, in watching the process of an attack by a spider upon a fly, he observed that, at the commencement, only two or three spinnerets were used to spin the web round the fly. The first portion of the web was like a quantity of floss silk, and then, as the web converged towards the fly it became more like a gut-line. After a while the fly began to struggle, and then the spider used some more web, and finally used all five spinnerets. He thought, from what he had seen, that the quantity or quality of the web depended upon what the spider wanted to use it for, and, according to this, he used more or less of the spinnerets.

The President inquired whether Dr. Anthony should not have used the word "she" in speaking of the spider. Was it not the female spider which spun the webs?

Mr. Stewart said he had often seen the male spider in the middle of a web waiting for his prey, and always thought it was his own web, for he certainly would not venture into the web of a female, knowing very well what his fate would be. He believed that the explanation given was quite correct, and that not only were the spinnerets of varied form, but the glands inside them were different in structure so as to be able to produce different kinds of threads. The cross threads, it might be observed, contained an axis of comparatively hard, dry thread, which was exceedingly elastic, and the outside portion was glutinous, like birdlime, and remained so for years. If the thread was stretched this would be seen to be the case; the gelatinous portion would break up into beads.

Mr. Beck said that it was quite easy to examine the different kinds of webs which were spun by a spider, and if they allowed the spider to run out one of the glutinous threads, they could observe the formation of the web and the globules. He had had frequently to use spiders' webs for the cross-lines of transit instruments, for instance, and the kind used were not at all adhesive. Any one who had watched a spider encasing his prey would have noticed how entirely the web seemed to be under command, and that there appeared to be a remarkable power of changing the character of the web at will. The spinning-organs were very highly developed and would form a very good subject for a monograph.

Mr. Crisp referred to the researches of the Rev. H. C. McCook on spiders' webs.*

Dr. Matthews inquired how it was that the spider dropped or divided his web without using his jaws, and how it was that he climbed up his web, if it was composed of glutinous threads?

Mr. Beck said that a spider did not always use glutinous threads. The radial lines of the web were not glutinous; neither were those which were used to tie the web fast to neighbouring objects; but only the transverse lines.

Mr. Michael said that any one who watched a spider, would see that he took great care not to put his foot on the transverse lines of his web; but that in running across it he always walked on the radial lines only.

Mr. Crisp said that in a letter to Mr. Mayall, Dr. Anthony had anticipated Dr. Matthews' query as to the division of the web, and proposed to show in a further communication on the spinnerets that the spider did not use his jaws for the purpose, but that there was a special apparatus at the end of the spinnerets. The diagram accompanying the letter illustrating this apparatus was enlarged upon the black-board by Mr. Stewart.

Mr. Badcock said he had brought some specimens of *Lophopus crystallinus* to show what might be found in the depth of winter. A pond in Epping Forest a few days ago had what looked like a mass of fungi in the middle of it, and on examination it turned out to be an immense quantity of Polyzoa. He thought that naturalists often failed to find things because they did not look for them in the winter.

* See this Journal, ii. (1879) p. 559, and Proc. Acad. Nat. Sci. Phila. 1881.

The pond in question contained nothing of any consequence in the summer.

Mr. Stewart said that the specimen exhibited by Mr. Badcock was the finest he had ever seen.

The following Instruments, Objects, &c., were exhibited:—

Mr. Badcock:—*Lophopus crystallinus.*

Messrs. Beck:—New Condenser (see p. 141).

Mr. Crisp:—(1) Beck's Miner's Binocular Microscope. (2) Photograph by Mr. Jennings of ·001 grain of arsenic × 400. (3) Mauler's blue glass slides.

Mr. Forrest:—New Compressorium.

Dr. Gibbes:—(1) *Bacillus anthracis* in lung. (2) Section of tongue treble stained and injected.

Mr. Kitton:—*Eupodiscus argus* mounted in gum-juniper.

Mr. Stephenson:—Specimens illustrating his paper on mounting.

Mr. Stewart:—Gregarinidæ from vesiculæ seminales of the earthworm.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. W. J. Abel, Herbert C. Chadwick, Walter H. Mead, and James Warnock.

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

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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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FELLOWS OF THE SOCIETY.

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Ser. 2.—Vol. II. Part 2.

(APRIL, 1882.)

CONTENTS.

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

BOTANY.

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

Royal Microscopical Society.

MEETINGS FOR 1882,

AT 8 P.M.

1882.	Wednesday,	JANUARY	11
	„	FEBRUARY .. .. *(Annual Meeting for Election of Officers and Council.)*	8
	„	MARCH	8
	„	APRIL	12
	„	MAY	10
	„	JUNE	14
	„	OCTOBER	11
	„	NOVEMBER	8
	„	DECEMBER	13

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.

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ELECTED 8th FEBRUARY, 1882.

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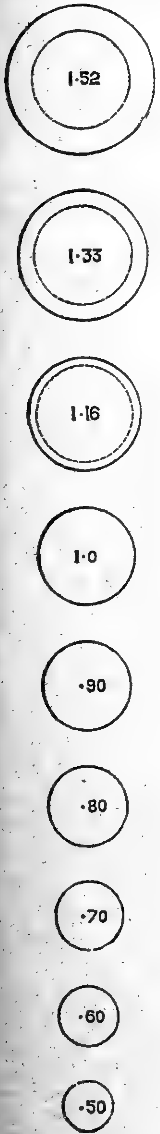
I. Numerical Aperture Table.

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

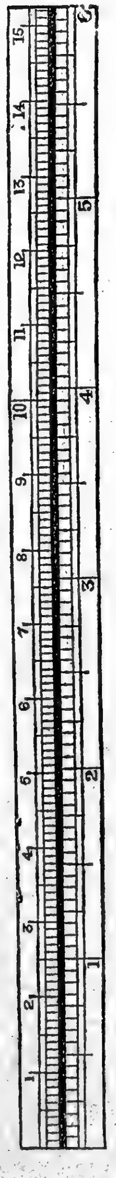
EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

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	6·349949
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	2·116649
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

(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
	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 cf 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

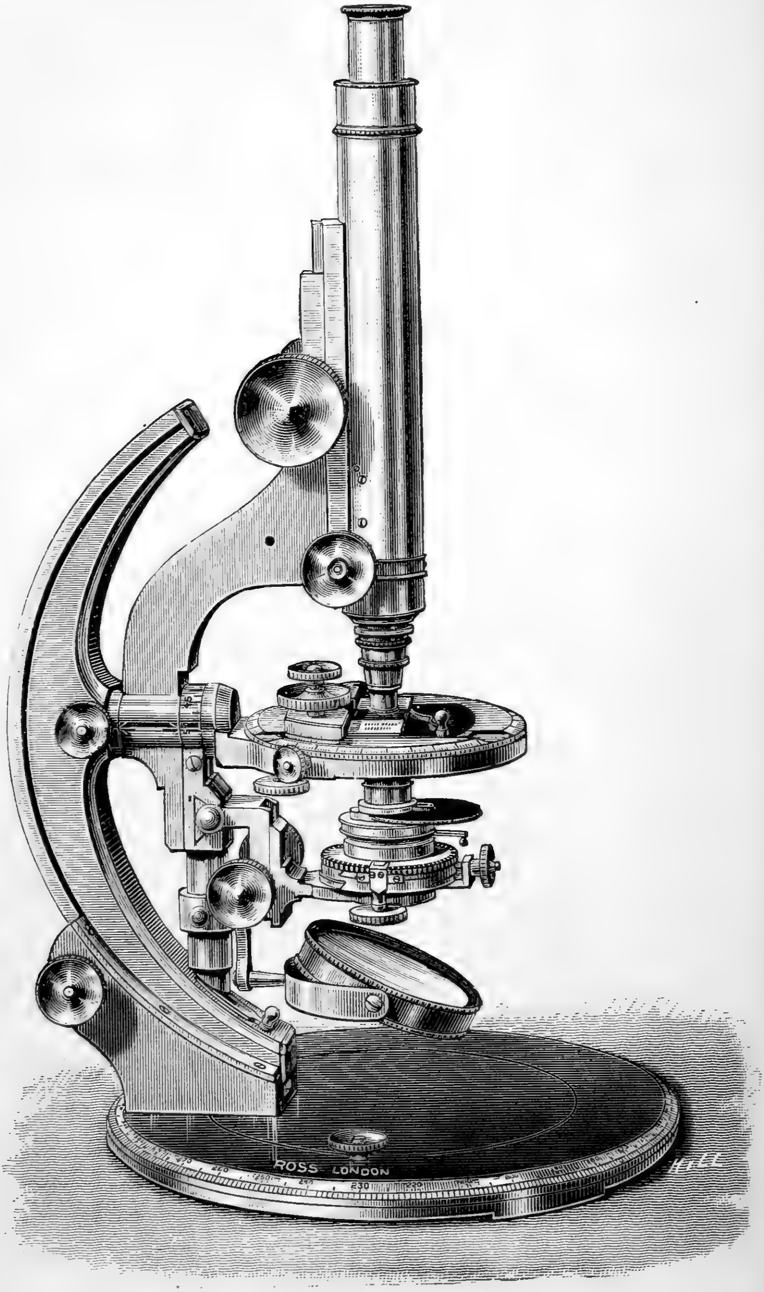
[Exact data for these tables are at present wanting.]

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.	1⅓ in.	1 in.	⅘ in.	⅔ in.	½ in.	4/10 in.	⅓ in.	¼ in.
		MAGNIFYING POWER.								
		5	7½	10	12½	15	20	25	30	40
ins.		AMPLIFICATION OF OBJECTIVES AND EYE-PIECES COMBINED.								
5	2	10	15	20	25	30	40	50	60	80
4	2½	12½	18¾	25	31¼	37½	50	62½	75	100
3	3⅓	16⅔	25	33⅓	41⅔	50	66⅔	83⅓	100	133⅓
2	5	25	37½	50	62½	75	100	125	150	200
1½	6⅔	33⅓	50	66⅔	83⅓	100	133⅓	166⅔	200	266⅔
1	10	50	75	100	125	150	200	250	300	400
8/10	12½	62½	93¾	125	156¼	187½	250	312½	375	500
	13⅓	66⅔	100	133⅓	166⅔	200	266⅔	333⅓	400	533⅓
⅔	15	75	112½	150	187½	225	300	375	450	600
	20	100	150	200	250	300	400	500	600	800
4/10	25	125	187½	250	312½	375	500	625	750	1000
	30	150	225	300	375	450	600	750	900	1200
3/10	33⅓	166⅔	250	333⅓	416⅔	500	666⅔	833⅓	1000	1333⅓
	40	200	300	400	500	600	800	1000	1200	1600
⅕	50	250	375	500	625	750	1000	1250	1500	2000
	60	300	450	600	750	900	1200	1500	1800	2400
1/7	70	350	525	700	875	1050	1400	1750	2100	2800
	80	400	600	800	1000	1200	1600	2000	2400	3200
1/9	90	450	675	900	1125	1350	1800	2250	2700	3600
	100	500	750	1000	1250	1500	2000	2500	3000	4000
1/11	110	550	825	1100	1375	1650	2200	2750	3300	4400
	120	600	900	1200	1500	1800	2400	3000	3600	4800
1/13	130	650	975	1300	1625	1950	2600	3250	3900	5200
	140	700	1050	1400	1750	2100	2800	3500	4200	5600
1/15	150	750	1125	1500	1875	2250	3000	3750	4500	6000
	160	800	1200	1600	2000	2400	3200	4000	4800	6400
1/17	170	850	1275	1700	2125	2550	3400	4250	5100	6800
	180	900	1350	1800	2250	2700	3600	4500	5400	7200
1/19	190	950	1425	1900	2375	2850	3800	4750	5700	7600
	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
1/25	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
1/40	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
1/60	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
	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 1/75 less and 1/15 more than the figures given in this column.


H. CROUCH, LONDON



Wenham's Universal Inclining and Rotating Microscope.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL 1882.

TRANSACTIONS OF THE SOCIETY.

IV.—*The President's Address.* By Prof. P. MARTIN DUNCAN, M.B. Lond., F.R.S., &c.

(*Annual Meeting, 8th February*, 1882.)

My first and saddest duty in addressing you this evening, is to record the names of those who have passed away from among us during 1881. These are:—C. J. H. Allen, H. H. Bigg, Sir A. Brady, R. C. Griffith, T. E. W. Knight, W. Moginie, E. B. Pitchford, F. Symonds, and J. Tennant.

Of some of these we have not received any obituary notices; those which have been sent to us will be printed in our 'Proceedings.'

While we regret the loss of so many of our Fellows, it is satisfactory to turn to the list of elections into the Society, and to find that, as stated in the Council's Report, we now have more Ordinary Fellows than at any previous period. In 1867 the numbers reached 452, but soon after that date, each year showed a falling off, until in 1878 there were less than 400 Fellows. In the three subsequent years there has been a large increase (after deducting all deaths and retirements), so that the present number is in excess of 500. Whether that total shall be again reduced, depends very much upon the influence which the Fellows may exert upon their friends and others, to induce them to join our ranks. I need hardly say that every addition enables us to increase our usefulness.

The Report of the Council contains an expression of passing regret that the Society is not furnished with the results of more original work on the part of its Fellows. It is, I know, often assumed that we have been worse off in this respect in later years than formerly, but if you will turn to the presidential addresses for 1855 and 1856 * (those of Dr. Carpenter) you will find that he gives expression to the same complaint, and in very strong

* Trans. Micr. Soc. Lond., iii. (1855) pp. 39–40; iv. (1856) pp. 17–21.

terms. Judging from his remarks, I should conclude that so far from having retrograded, we can show a substantial advance. Apart from the valuable papers on the Optics of Microscopy, to which I shall refer more in detail, we have had communications read at our meetings during the past year which were both interesting and important. The description of the beautiful Rotifers *Œcistes Janus* and *Floscularia trifolium*, by Dr. C. T. Hudson; Mr. Michael's description of the singular Acarus *Dermaleichus heteropus*, parasitic on the Cormorant; the notice of the remarkable disks of sulphide of iron found in the London clay and which are pseudomorphs of the silicious tests of *Coscinodisci* and other Diatomaceæ, by Mr. W. H. Shrubsole and Mr. F. Kitton; and the description of a supposed new boring Annelid, *Lithognatha worslei*, by Mr. Stewart, are papers which do credit to the authors.

When we consider, moreover, the large number of observations recorded during the past year by the various Societies which receive communications principally worked out by means of the Microscope, it cannot fail to be recognized that the activity and progress of microscopy are greater now than at any former time, and that the tendency is to still further increase. The most valuable part of our bi-monthly Journal is the summary which it contains of this stupendous amount of original work. The Microscope is moreover always being carried into new fields. It now promises to be of great assistance to the chemist, and while but a few years ago no one thought of including it among the essential tools of the geologist, it is extensively applied at the present time to the examination of rocks, and most valuable results have been brought to light by its aid. Instead then of allowing ourselves to be tempted to bemoan the "stagnation of microscopy" we, as a Society devoted to its study, may congratulate ourselves and the rest of the scientific world, that whether as regards theory or practice—the optical and mechanical or the observational part of our science—there has never been a time when so much evidence could be produced of solid progress as now.

Whilst we can, I think, usefully devote a little time in each year to the consideration of the results obtained in the previous one, it would be difficult within the compass of one annual address to deal with both branches of microscopical work; and therefore (the Society having done me the honour to elect me to the presidential chair for another year) I must reserve for a future occasion a notice of the discoveries in the animal, vegetable, and mineral worlds, which the Microscope has been the means of bringing to light since the commencement of the present decade. The adoption of this course is also supported by the fact, that the past year has been, I think, specially marked out by the important points in microscopical optics, which have, for the first time, been elucidated. In no previous year, so far as I can gather from a reference to the printed records of the Society, has so much light been thrown upon subjects which are of the first importance in microscopy.

I propose, then, briefly to recall the evidences of progress in this part of our science, which the past year affords.

The Abbe Theory of Microscopical Vision.

As a notable feature may be mentioned the greatly increased interest which has been awakened in the important contribution to the theory of the Microscope, originated by our illustrious Fellow Professor Abbe. Although those views are now several years old, and were brought before the Society so long ago as 1877 by our then Treasurer, Mr. J. W. Stephenson, the recognition of the extraordinary nature of the experiments, was until lately confined to a very small circle. Both in this country and in Germany and America, however, the past year has seen a great extension in the number of those who have followed these experiments, and who have appreciated the important bearing which they have on microscopical vision.

I have used the term "extraordinary" because I think that every one who has seen these experiments will readily agree that it is extraordinary, in every sense of the word, to find, that merely by excluding a greater or less number of the "diffraction" images found at the back of the objective, a great variety of entirely different appearances are presented by one and the same object—lines at a known distance apart doubled and quadrupled,—or that objects in reality quite unlike can be made to seem identical—multi-sided figures giving images of squares. In short, the *same* objects may appear to be *different* in structure and *different* objects may seem to be *identical*, entirely according as their diffraction images are made dissimilar or similar by artificial appliances between the objective and eye-piece. The appearance of particular structure can even be "predicted" by the mathematician, before it has been actually seen by the microscopist.

The result of these experiments is to show that a distinction must be drawn, between the vision of minute objects and what may be termed, for this purpose, "coarse" objects, i. e. those which are considerable multiples of the wave-lengths.

The latter are imaged by the Microscope, substantially in the same way as by the camera or the telescope, and their images correspond point for point with the object. We are therefore able to draw the same inferences as to the actual nature of such objects, as in the case of ordinary vision.

Minute objects, or parts of objects, only a few multiples of the wave-lengths, are, however, imaged in an entirely different way, viz.

by the diffracted rays produced by the action of the minute structure. If *all* the diffracted rays from the object are reunited and reach the eye, an image of the real structure is obtained. If *some* only of the rays are transmitted, the image is no longer necessarily a true representation of the object, and the smaller the admitted portion the more incomplete and dissimilar the image. Now as the objects become more and more minute, the diffracted rays are more widely spread, and fewer of them can be admitted by an objective even of largest aperture. The visible indications of structure in such images are not therefore necessarily conformable to the actual nature of the object under examination, and the only inference that we are entitled to draw from the image as presented to our eye, is the presence, in the object, of some of the many different structural peculiarities which are capable of producing the diffraction phenomena observed in the particular case.

Our veteran microscopist, Dr. Carpenter, C.B., has embodied, in the edition of his widely known work published during 1881, a statement of the leading points of the diffraction theory, which is valuable as containing the results of his own matured views on the subject. He says (p. 187), "This doctrine, originally based on "elaborate theoretical investigations in connection with the undu-"latory theory of light, has been so fully borne out by experimental "inquiries instituted to test it, and is in such complete harmony "with the most certain experiences of microscopists, that its truth "scarcely admits of a doubt."

There are one or two points that require to be kept prominently in mind in regard to the diffraction phenomena in question; 1st, that they are not to be confounded with the so-called "diffraction band" observed round the outlines of objects illuminated by oblique light, nor with the "diffraction" rings displayed by brilliantly illuminated globules; 2nd, that they are not confined to transparent objects illuminated by transmitted light, but are also produced by *opaque* objects; and 3rd, that they are not limited to lined or regular objects, but extend also to *irregular* structures or isolated elements of any shape; in fact universally, to structures of all kinds, whenever the uniform propagation of the luminous waves is disturbed by the interposition either of opaque or semi-opaque elements, or of transparent elements of unequal refraction, which give rise to unequal retardations of the waves. They therefore apply not merely to the "resolving power" of objectives, but to their general *delineating power*—the power of the Microscope to show things "*as they are.*"

The 3rd point is, I need hardly say, most important, and one which it will be very interesting to have more fully elucidated, having regard to Professor Abbe's statement that objects (such as the flagella of Bacteria) which are only a fraction of a wave-length in diameter, will necessarily appear to us, not in their proper proportions, but with greatly *increased* diameters, and that very minute striations must appear as if the dark and bright interspaces were nearly of *equal* breadth, although in reality not so.

There are obviously many histological problems, such as the question of the structure of muscle, which a proper knowledge of this part of the subject may greatly help to elucidate.

The facts which we now have before us in regard to microscopical vision, are sufficient to justify the injunction of Professor Abbe that "the very first step of every understanding of the Microscope is to abandon the gratuitous assumption of our ancestors that microscopical vision is an imitation of macroscopical, and to become familiar with the idea that it is a thing *sui generis*, in regard to which nothing can be legitimately inferred from the optical phenomena connected with bodies of large size." That there must be a great deal more yet to be elaborated in regard to the origin and nature of the phenomena we have been considering, is obvious, and I hope that the attention of our own physicists and microscopists will be directed to a subject of such extensive practical bearing, not merely to the theoretical microscopist, but to the large class of practical histologists who are entirely dependent upon the Microscope for the accuracy of their observations.

The Aperture of Objectives.

The "aperture question," as we all know, gave rise, several years ago, to a somewhat acrimonious controversy, not in the 'Proceedings' of the Society, but in the unofficial section of its then Journal, and doubtless there were some Fellows who, at the beginning of last year, regarded with no little apprehension the prospect of a revival of that controversy. But, notwithstanding the warmth with which it was debated in its new form, no one will, I am sure, deny the very great value that the renewal of the discussion —between Mr. Crisp and Mr. Shadbolt—has been in bringing to the light what had previously been confined to a few. If any one does not now comprehend how an immersion objective can have an aperture greater than that of a dry objective of 180°, at least it cannot be any longer charged against this Society, that means have not been provided to enable him to do so.

The essential difference between the old and the new view of aperture is simply, that the former considered only the rays which *enter* the objective, while the latter deals with those which *emerge* from it.

The disadvantage of the former method, which estimated the incident pencils entirely by their angles, has been its inevitable tendency to give a fictitious importance to the angle of the entering pencil, which was supposed to have a special virtue of itself, in the delineation of objects. Naturally, therefore, the same angles, whether in air or any immersion fluid, were considered to produce an equal effect, and the advantage of immersion objectives was rested on minor points.

An estimation of the emergent beam, however, must obviously give the same result as one of the incident beam (assuming them both to be correctly made), it being of course impossible for anything to emerge that has not first been admitted. But to quote Mr. Crisp:—"The great and obvious advantage in dealing with the emergent pencil is that it is always in air, and so the perplexities are eliminated which have enveloped the consideration of the admitted pencil, which may be in air, water, oil, or other substances of various refractive indices." *

The subject of aperture is not, in reality, a difficult one, and any intricacy in which it may seem to be involved will be found to arise from the necessity of clearing away some of the old entanglements, such as the curious mistake involved in the "hemisphere puzzle" and similar matters. Looked at *de novo*, there are two simple stages in the aperture question.

(1) To appreciate that, in using the term "aperture," we use it not in any artificial sense, but as meaning opening and nothing else,—defining, simply, the capacity of an objective for receiving rays from the object and transmitting them to the image.

(2) That the aperture (as so defined) of an objective is determined by the ratio between the diameter of the emergent beam and the focal length of the objective. According as this ratio is greater or less, so the objective will receive and transmit a larger or smaller portion of the total quantity of rays presented to it.

The emergent beam of an air objective of 180° angle cannot exceed in diameter twice the focal length; that of a similar water-immersion objective may be one-third larger, and of an oil-immersion half as large again, and the relative capacities of such objectives (with equal angles) to receive and transmit rays will always be as 1, $1\frac{1}{3}$ and $1\frac{1}{2}$.

It cannot be too carefully borne in mind that it is not a question of this or that theory, but the ordinary laws of geometrical optics which determine that, all other things being equal, one objective will receive and transmit a greater quantity of light than another,

* As pointed out by Mr. J. Mayall, jun., at the commencement of the discussion, if 180° in air is equivalent to 82° in glass, the 140° in glass of the immersion lens must represent something *more*. This fact is, however, so constantly misinterpreted, owing to the supposition that when the immersion fluid is introduced the effect is only that the 82° is no longer compressed by the action of the plane surface of the lens, but is allowed to expand to 140°. This is one only of the apparent difficulties that obscure the proper estimation of the incident pencil, and which are avoided by dealing with the emergent beam.

and therefore has the larger or smaller aperture, according as the diameter of the beam emerging from it is greater or smaller.

As Fellows of this Society we may, I think, be proud of the able communications, relating to this subject, which were published last year in the April and June numbers of the Journal.

Numerical Aperture.

The abandonment of the angular notation for aperture necessarily follows, as soon as the correct view of aperture is appreciated; for when we know that the apertures of three objectives are, for instance, as 98, 126, and 138, no one would insist that they should be designated 157°, 142°, and 130°. A notation can have no title to be considered a scientific one, which denotes things as the same when they are really different (60° in air and oil) or different when they are the same (180° in air and 82° in oil).

Until, however, the "law of aplanatic convergence" had been demonstrated by Professor Abbe, no principle had been established by which the ratio between emergent beam and focal length, could be conveniently denoted.

It would not be possible for me to condense, without a sacrifice of intelligibility, the steps by which he subsequently showed, in a very beautiful manner, that the ratio in question can be expressed by the product of the refractive index of the medium in front of the objective, and the sine of half the angle of aperture, that is by $n \sin u$.

Taking for our *unit* the capacity of an objective for collecting the whole hemisphere of rays from an object in air (i. e. the case of a dry objective of 180° angle) we obtain the "numerical" notation, which commencing with the lowest numbers advances as far as 1·52 with oil-immersion objectives, and by the use of which not only are apertures compared in the same medium, but in different media also, and we see whether they are smaller or larger than the maximum of a dry objective.

It is gratifying to find that the reproach hitherto attaching to microscopists, for the use of a misleading notation, is, thanks to the efforts of this Society, being rapidly removed, and that the initials N.A. are no longer so mystic a symbol as they have been. I understand that many of the opticians have decided to use the numerical notation in the future issues of their catalogues, which is a step in the right direction, which we shall hope to see generally followed.

Whilst on this subject I may point out how important it is that in observations with high-power objectives, their aperture as well as magnifying power should be stated. Whether a large or a small aperture has been used, may make a very material difference in the value to be attached to the results described.

The "Homogeneous Immersion" principle.

The utility of homogeneous-immersion objectives being established beyond doubt by practical experience, it is interesting to note that the origin of the principle is very fully recognized by Professor Abbe to be due to our esteemed Fellow Mr. J. W. Stephenson.

The two essential points in homogeneous immersion are, 1st, the increase in aperture obtained by the use of a fluid of high refractive index and, 2nd, the enhanced optical performance arising from the total suppression of spherical aberration in front of the objective. Professor Abbe states that although Amici first applied oil immersion, he failed to recognize the specific advantage of an immersion fluid being as near as possible in refractive and dispersive powers to the crown glass (i. e. "homogeneous"). He finished his lenses and then sought for oils and mixtures of oils of various refractive powers for obtaining the best correction. "It was Mr. Stephenson who, in his first communications with me, expressed the opinion that doing away with the anterior aberration would improve the defining power, and especially would afford very favourable conditions for further increase of aperture."

The importance of this system will be appreciated when we remember, in regard to the first point (the increase of aperture), that the theoretical resolving power of an objective is thereby raised from 96,400 lines to an inch, which is the maximum of a dry objective, to 146,528 the maximum of an oil-immersion objective, the illuminating power being also increased from 1 to 2·25: while as regards the second point, we are able by the homogeneous-immersion method to reduce the problem of correcting a very wide-angled objective to the much less difficult one of correcting an objective of *moderate air angle.* Our lamented President, the Rev. J. B. Reade, declared in 1870 that "the ghost of aberration will never be entirely exorcised even by cold water." But there appears to be good ground for believing that oil has practically accomplished that object.

During the past year several kinds of fluids for homogeneous immersion have been brought before the Society, such as chloral hydrate and glycerine, iodide of zinc and glycerine, and gum dammar and cedar-oil. Two other vegetable products have also reached us, "tacamaque" and the gum-resin "oliban," or "incense," both dissolved in cedar-oil. While the dammar is claimed to be unchangeable, and to be in refractive and dispersive powers very near that ideal of a good immersion medium, "fluid crown glass," there is evidently room for further research in this direction, particularly for a fluid which will not attack the various varnishes in ordinary use.

Lastly must be noted an important advance in practical manufacture by the construction, by Messrs. Powell and Lealand, of a homogeneous-immersion objective of the large aperture of 1·47 N.A. out of a possible 1·52. As long ago as 1850 one of my predecessors in this chair, expressed the belief that objectives had then "nearly, if not quite, attained the limit of perfection," and whilst it will be prudent even at this much later date to avoid any assertion of finality in the present, or scepticism as to the possibilities of the future, it must be admitted that so far as regards aperture and resolving power we have arrived at a point beyond which it will, to all appearances, be difficult to advance, at any rate not without serious restrictions in the use of the objectives. Whilst it might be possible to work front lenses for objectives out of diamond, and so to increase the aperture to 2·5 N.A., and the resolving power to 241,000 lines to the inch, it must be remembered that it would be essential at the same time to provide an immersion fluid, slides, cover-glasses, and illuminators of the same refractive index as diamond also.

Penetrating Power of Objectives—Depth of Vision.

This again is a subject which has long been obscure; very various opinions being held as to the true nature of what has been generally termed the "penetrating power" of an objective. By some it has been declared to be a defect in the construction of the objective—residual uncorrected spherical aberration, in fact; and by others as necessarily inconsistent with perfect definition, even with the best methods of construction; the only approximately correct notion regarding it, being that it decreased as the angle of aperture increased.

Professor Abbe, however, in a very valuable paper, placed the question on the scientific basis so long needed, showing that the total *depth of vision* in the Microscope, i. e. the solid space which at *one* focus of the Microscope is visible with sufficient distinctness, depends not merely on the *depth of focus* of the objective, but is the sum of that and the *depth of accommodation* by the eye.

The depth of focus (other conditions remaining the same) varies in inverse ratio to the magnifying power and also to the numerical aperture of the objective. Thus with a $\frac{1}{4}$-inch and $\frac{1}{8}$-inch of the same aperture the depth of focus of the former would be twice that of the latter, or if the powers are the same but the apertures are ·50 N.A. and 1·50 N.A., it would be as 2 to ·66.

The depth of accommodation depends upon a point which was entirely new to microscopists until developed by Professor Abbe, viz. the peculiar property of microscopical amplification, by virtue of which the linear amplification of the depth of an object is largely exaggerated, being equal to the square of the linear amplification laterally. Thus an object magnified, according to ordinary parlance, 100 linear diameters (i.e. in breadth) is magnified 10,000 linear diameters in depth. Now the depth of accommodation varies in inverse ratio to this depth-amplification, that is inversely to the square of the magnifying power, so that whilst large with the low powers, it decreases very rapidly and disproportionately as the power is increased.

The joint effect, therefore, of the diminution in the depth of focus and depth of accommodation is that the total depth of microscopical vision diminishes, not in the same ratio as the increase in the magnifying power, but at first in a much greater ratio. With the low powers we have considerable depth of vision, as it is then chiefly influenced by the large accommodation-depth. As we proceed to the medium powers (100–300) the accommodation-depth very rapidly diminishes, and becomes equal to that of the small depth of focus, so that the total depth of vision is necessarily small also. As the power is further increased, the accommodation-depth ceases to have any influence, and the depth of vision becomes principally depth of focus only. If, for instance, an amplification of 30 times is increased to 300, the depth is reduced not to $\frac{1}{10}$ but to only $\frac{1}{50}$ of its original amount; or taking the depth of vision with a power of 10 times to be 2 mm., with powers of 30, 100, 300, 1000, and 3000, it is only ·254, ·0273, ·0047, ·00094, and ·00026 mm.

The formula

$$\text{Depth of vision} = n\left(\frac{L^2}{N^2}\lambda + \frac{L}{N}\frac{\omega}{a}\right)$$

shows at once how much the depth of vision may vary by a change in the conditions—represented by the various factors in the formula —which make up the total effect, important among which, as will be seen from the form of the equation, is the refractive index n of the medium in which the object is mounted.

Micro-Stereoscopic Vision.

The determination of the depth of vision (in monocular observation) naturally throws great light also on the conditions for effective micro-stereoscopic vision. It is obviously only when an object can be completely *seen* in all three dimensions at one adjustment of the focus, that a true stereoscopic image of it can be obtained. So long as only a single layer of inappreciable depth is visible simultaneously with any distinctness, no stereoscopic apparatus, however perfect, can bring into view the form of the whole of the object.

Now with low powers we have large visual depth, so that objects of considerable thickness can be seen as solids. By reason, however, of the rapid decrease of the depth of vision to which I have referred, the thickness of the objects which can be seen in relief, rapidly and disproportionately decreases as the power is increased, so that only very thin objects are suitable with even the *medium* powers, the absolute depth, in the case of an object magnified 300 times, not amounting to a hundredth of a millimetre. With still higher powers the images of solid objects (though the decrease in depth is no longer so irregular) necessarily approach more and more to simple plane sections, the absolute depth with a power of 1000 times amounting only to a micro-millimetre. For medium and high powers, therefore, the only objects suitable for the stereoscopic binocular, are those which present, within a *small* depth, a sufficiently characteristic structure, that is, which have sufficient salient points for stereoscopic effect. We can, however, increase the depth of vision by using narrow illuminating pencils, and by mounting the objects in some highly refractive substance. The above considerations also show the importance of using the *lowest* power sufficient to recognize the object.

Whilst the reduction in depth limits effective stereoscopic observation, Professor Abbe properly points out that there is a compensating advantage in ordinary microscopic observation, in that as the depth-perspective becomes more flattened the images of different planes stand out from each other with still greater distinctness, so that "with an increase of amplification the Microscope acquires more and more the property of an *optical microtome*, which presents to the observer's eye, sections of the object of a fineness and sharpness that no instrument could produce by mechanical means."

Another novel point was the demonstration of the very material distinction between ordinary stereoscopic vision and that with the Microscope. The perspective shortening of the lines and surfaces by oblique projection, which is an important element of solid vision with the naked eye, is wholly wanting in microscopical vision, in which we have only the other element, a relative displacement of successive layers in the image. That these displacements are seen in the Microscope, depends entirely on the peculiar exaggeration in the amplification of the depth of an object which is not found in ordinary vision.

The paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope" is also a most useful contribution to the theory of micro-stereoscopic vision, establishing as it does the true criteria for both classes of effects, and at the same time clearing up a misconception that had arisen as to the supposed necessity for the rays from the two halves of the objective *crossing* in order to get proper orthoscopic effect. If the delineating pencils have been reflected an *even* number of times in the same plane, the rays must cross, but otherwise not.

Mounting-Media of High Refractive Indices.

To utilize the full benefit of immersion objectives, it is of course essential that the object should be mounted in a medium, the refractive index of which is not less than that of the immersion fluid; and down to a comparatively recent period Canada balsam was most commonly used for this purpose, particularly for diatoms.

Mr. Stephenson, however, pointed out that although by the use of the balsam we have attained our object so far as the aperture is concerned, yet we have done so at the expense of the visibility of the resultant image, which has become fainter by the nearer approximation to equality of the refractive indices of the diatomaceous silex and the balsam; the visibility of minute structures being proportional to the difference between the refractive indices of the object and the medium in which it is mounted. Instead of balsam, therefore, media of high refractive index should be employed; thus, as the refractive indices of diatomaceous silex and Canada balsam are respectively 1·43 and 1·54, the difference ·11 is the measure of the visibility of a diatom in balsam. Using a solution of phosphorus in bisulphide of carbon, the refractive index of which is 2·10, the difference is ·67, and the visibility of the diatoms is now more than six times as great as it was in the balsam.

Continuing his researches on this subject, and endeavouring to find the best media with high refractive indices, he has quite lately brought before the Society the utility of an *aqueous* fluid capable of being given the high refractive index of 1·68, viz. a solution of biniodide of mercury and iodide of potassium in distilled water. This more manageable and highly antiseptic medium appears likely to turn out to be of great use in the observation of many objects, as its strength can be diluted till the index of water is obtained. This is of advantage with such objects as muscular fibre, which are themselves of high refractive power, so that fluids of *low* refractive power must be made use of to obtain the required difference for more perfect visibility. The same communication also contains what was much wanted, detailed practical directions for mounting.

Any one who has seen the diatoms and scales mounted in phosphorus by Mr. Stephenson's method, and exhibited at our meetings during the past and present sessions, cannot fail to have been struck by the great increase in their visibility as compared with those mounted in balsam, or to have recognized the fact, that the theoretical consideration by which their visibility was pronounced to be much increased, was not unfounded.

In addition to the increase in visibility, there is also the fact that by means of such mounting fluids, the capacity of stereoscopic binoculars with the higher powers is considerably enhanced. True stereoscopic effect, as we have seen, requires a depth of vision not less than the thickness of the object under observation — a depth which, as already shown, increases in direct proportion with the increase in the refractive index (n) of the mounting fluid. If one object is in air when $n = 1 \cdot 0$, whilst another is in a solution of phosphorus, where $n = 2 \cdot 1$, the depth of vision will be more than doubled. Objects, therefore, that by reason of their thickness could only afford an unsatisfactory stereoscopic effect in air may be seen in full relief when mounted in phosphorus.

Here, again, the deductions of theory were remarkably verified by the recent exhibition of *Surirella gemma*, under the binocular, with a $\frac{1}{25}$-inch objective.

Relative Value of Objectives with Large and Small Apertures. (*"All-round Vision"*).

I now come to a much-vexed question, that of the relative value, practically, of objectives of large and small apertures, in regard to which a great variety of opinions have been promulgated.

The oldest of these views was that which made the preference between the two kinds of objectives, depend upon whether they were to be used for the "ordinary purposes of the biologist," or for the examination of diatoms or other lined objects. The objection to this view is, that it assumes the only function of a large aperture to be its resolving power, a much too restricted notion, and one which deprives the working biologist of a most essential aid to his observations upon structure.

A more modern view errs in the opposite direction, and insists upon the universal superiority of large apertures, so that work done with small apertures will "have to be done over again."

There is again a third view, still more recently put forward, which goes much further than the preceding, and according to which it is impossible that wide apertures can give correct images. First on account of the unnatural "all-round vision" which it is contended is obtained with them, and secondly by reason of their supposed inherent defect in defining power, in consequence of the dissimilar images presented by the different parts of the enlarged area of the objective, with a confused image as the general resultant.

The want of exactness in the first two suggestions will sufficiently appear, when we have formulated the grounds upon which large apertures are shown to be indispensable for all observations upon minute structure for which high powers are necessary; but it will be desirable first to point out the erroneous interpretations upon which the third view (as to all-round vision and dissimilar images) has been founded, and for this purpose it will be necessary to refer to the paper by Dr. Royston-Pigott, F.R.S., in which the subject is dealt with.*

After reminding his readers that he had shown that spider-lines, miniatured down to the fourteenth part of the hundred-thousandth of an inch, were distinctly visible to ordinary good eye-sight under proper microscopical manipulation (an experiment which, I may remark in passing, has not a satisfactory foundation), Dr. Pigott says:—"Under these circumstances it was interesting to know whether real objects could be detected by the Microscope in the surprising degree of attenuation represented by the millionth." Minute particles of mercury were obtained by smashing some with a watch-spring, and they were mounted in petroleum under a thin cover. A vertical illuminator was used to converge rays downwards, through the objective, upon the preparation. In a darkened room minute disks became visible, and upon some of them clusters of minute black points were seen with a power of 1000 diameters. Comparing them with a micrometer spider-line $\frac{1}{10000}$ inch diameter, some of the points were found to be decidedly smaller. Under 1000 diameters the particle was magnified one hundred times in the micrometric focus, and then appeared less than the spider-line. Its real diameter was therefore less than $\frac{1}{100}$ of $\frac{1}{10000}$ inch, or less than the millionth of an inch, and the writer draws the conclusion that "real objects of unsuspected minuteness may be microscopically displayed as well as minute miniature images." To this part of Dr. Pigott's observations it may be pointed out that it has never been supposed, so far as I am aware, that there is any limit of *visibility* in the Microscope other than that imposed by the sensibility of the observer's retina, the correction of the objective, and the illumination. The question of a limit of visibility is quite distinct from that of a limit of separation, just as in telescopic vision a single star is always visible, however small its visual angle, provided it is sufficiently *bright*, but a double-star requires a certain minimum aperture of the objective, dependent on the angular distance of both stars.

Discussing the variability of the blackness and thickness of the marginal annulus of refracting molecules, as exemplified in a glass spherule ·1 inch diameter, and in the featherlets of the death's-head moth and plumelets of *Hipparchus Janira* with objectives of 20° Ang. Ap. power 200, and 140° Ang. Ap. power 800, he writes:—"If then the minute fibrillæ of the plume can be clearly distinguished as closely packed black lines at a visual angle of 20 seconds with a low aperture of 20°, this result is fatally opposed to the popular idea that very close lines, or very minute lines or bodies, can only be distinguished with large angular aperture.

* Proc. Roy. Soc., xxxi. (1881) pp. 260-78.

These lines were most sharply seen though less than $\frac{1}{80000}$ inch thick." After noting the disappearance of distinctive shadows and consequent obliteration of structural molecules with excessive angular aperture, illustrating his meaning by the structure of Podura scales, with different stops and under very varying conditions, Dr. Pigott states that he has come to the conclusion that residuary aberration was not the only cause of the obstinate obscuration of minute crowded molecules in translucent organic forms, but that

> "Excessive angular aperture, he found, attenuated margin. . . . There is, it may be said, something unnatural in the mode of vision intrinsic to very high angled glasses. It is undoubtedly true that such a glass presents an *all-round vision*. It really conveys visual rays from a given brilliant particle, at every inclination in azimuth and altitude, and this too at one and the same instant. To illustrate this position a minute die may be imagined the $\frac{1}{100000}$ inch broad. The highest angled objective really enables the observer to collect rays emanating from *four sides* and the top at the same instant. The human eye could at most view *three sides* at once. Doubtless the effect of this angular vision all round the corners, causes particles to look spherical, when sufficiently minute, even if cubical."

Now it is necessary to say plainly that this view is founded upon a fundamental error, "belonging," to use Professor Abbe's words, "to the venerable relics of the past *naïve* period of microscopical science, which was characterized by an unshaken conviction in the validity of the hypothesis that microscopical vision is in all essential respects the same thing as ordinary vision." The "all-round vision," by virtue of which we are supposed, when looking at a minute cube, to see at the same time the top and all the sides (with the result of rounding off the corners and angles!), does not really exist, as can be shown by the application of the simplest laws of *geometrical* image formation. The different obliquities of the rays in an objective of wide aperture cannot give rise to any all-round vision, for in the Microscope there is no difference of *perspective* attendant upon oblique vision as with the naked eye. The difference of *projection* of successive layers which exists is ineffective, except in the case of binocular vision. This absence of perspective may be readily established by examining an object alternately by an axial and an oblique ray; it will be found that there is no shortening of the lines in the latter case, and no capacity in the Microscope, therefore, for "all-round vision." Indeed if this theory were correct, microscopical vision, even of *plane* objects and with very moderate apertures, would be entirely destroyed.

Equally mistaken is the second branch of the view which I am considering, viz. that a wide aperture must, in the nature of things, impair definition on account of the increase, thereby produced, in the dissimilar images received through the several parts of the objective. In support of this view, illustrations drawn from stereoscopic vision are adduced, which admittedly does depend upon the dissimilar images formed by the right and left hand halves of the objective; but, as Professor Abbe has shown, the dissimilarity of images presented by an objective of wide aperture is a dissimilarity in the projection of *successive layers* only, and this is *not effective* unless we produce these images by different portions of the aperture *separately and conduct them to different eyes,* as in binocular Microscopes. The sole effect of the wider aperture when the images are not so separated, is a reduction in the depth of vision—to confine us to the vision of thinner objects, not to impair the definition of what is seen when the objects *are* within the range of penetration.

If we pass to practical experience, we shall find that the principles which theory establishes are amply confirmed. All who have worked with wide-angled objectives cannot fail to have recognized the great fact of modern practical optics, the perfection of definition obtained with such glasses—a fact which has been verified by such authorities as Mr. Dallinger, who, so long ago as 1878, stated of a new $\frac{1}{8}$-inch homogeneous-immersion objective of the wide aperture of 1·25 that "the sharpness and brilliancy of the definition which this lens yields is absolutely unsurpassed in my experience."

The question of the power of resolution supposed to be possessed by small apertures can also be brought to a very simple practical test by those who believe in that view exhibiting here to the appreciative assemblage which they would have around them, say 75,000 lines to an inch resolved with the low apertures referred to!

We have seen that on the one hand the depth of vision decreases as the aperture is increased, and that on the other as the objects become smaller and smaller the similarity of their images increases with the increase in the aperture—the one representing a disadvantage attendant upon large aperture and the other an advantage—and bearing this in mind we are in a position to arrive at a correct view of the relative value of objectives with large and small apertures, which I take to be this:—

Both kinds of objectives are necessary for investigations into the structure of *minute* objects, and an observer to be fully equipped, should provide himself with *two* objectives, one of moderate and one of wide aperture. The former would be used for the more general survey of the various parts of the object, and the latter for the subsequent examination of its minute structure. In searching, for instance, through a stratum of fluid for Bacteria a wide aperture would be unnecessary, but when a particular Bacterium is found, it is only that which will give us an accurate view of its flagellum.

But again, in the choice of the objectives, the *proper relation between magnifying power and aperture* must be maintained. For work with low powers, it is useless to have large apertures. The structure of the objects for which such powers would be used is not sufficiently minute to require large apertures for their proper delineation, and we therefore expose ourselves to the disadvantage of very restricted penetration and the trouble of delicate manipulation, without any corresponding benefit.

On the other hand, it is equally useless to work with high powers (that is upon minute objects) with small apertures. We should have only an empty amplification—mere increase in the distance apart of the outlines, without any additional structure being made visible in consequence of the defect in aperture.

Whenever the subjects of our examination are so minute as to *require* high amplifications in order to be seen, then we must also have large apertures in order to obtain perfect delineation of the objects.

Leaving now the theoretical questions, which after all have so important a bearing on our practical work, reference only need be made to the descriptions published in our Journal of new inventions in regard to mechanical and optical appliances (most of which have been exhibited at our meetings) to prove that great progress is being made in the designing, manufacture, and application of the Microscope. Improved stands and eye-pieces, new immersion lenses, stages, and swinging substages, more effective fine movements and elaborate accessory apparatus of all kinds, indicate not only the activity of mind and the abundance of the resources of the microscopical optician, but that these things are really required in a progressive science.

It is to be hoped that the possession of excellent instruments and convenient apparatus will incite many of the Fellows to undertake more careful researches into the minute details of organic nature, or amongst the very fascinating rocks which are being so beautifully cut and mounted by petrologists. It is true that the difficulty of getting upon a path of original research is very deterrent. The activity of Continental and American microscopists is indeed great, and it is always necessary, before committing oneself to any statement, to search and prove its originality. Much microscopical research is quite beyond the powers of the man who has other avocations, and to whom the instrument is a pleasing, and none the less important, toy. Consider the paraphernalia required to study the microscopy of the details of a minute animal.

It has to be put into hardening and water-absorbing solutions, then to be cut with microtomes, perhaps frozen in the first instance, then to be put into other solutions to be cleared and to have its fat got rid of, and then it has to be coloured once, twice, or thrice, and possibly to have some colour discharged. Finally it has to be mounted in a medium. It is necessarily somewhat deterrent for a modest microscopist to read the excessively pronounced opinions of manipulators, about the nature of the structure they discover in such complicated and altered organic matter, and to find that very contradictory opinions are published by different investigators about the nature of identical structures which have been differently prepared. It appears to many an amateur, who happens to investigate structures by disturbing their natural condition as little as is possible, that he is, as it were, out of the field. He may find it necessary, even in examining the simplest section, to pay especial care to the illumination and centering, and to the application of particular powers. He is, of course, conscious of inferiority, when he knows that somebody merely puts a chemically treated specimen under an objective without the least care about optics, and finds out, or thinks he finds out, the truth. But there are numerous opportunities for original research still to be met with in the structure of many of the commonest invertebrates and plants. The study of rocks is in its infancy, and there are many very interesting physical questions yet to be determined, and which can only be settled microscopically. Recondite manipulation is not much required in any of these researches, but rather a good knowledge of how to use the Microscope as an instrument.

If in any case there are obstacles to original research, it is always interesting to follow the work of some distinguished investigator. It is very rarely that a subject is treated exhaustively, and the sedulous yet candid critic, may solve truths which his predecessor had not approached.

In concluding this address, I cannot avoid a special mention of the recent death of a man whose genius and careful microscopical work, established an era in histology, and influenced that study of embryology which must ever be the starting point of philosophical zoology and botany. Theodore Schwann elaborated the "cell theory" forty-three years ago, and in the main it holds good at the present day. He lived to see its value appreciated by every zoologist, and to be able to follow the researches with improved lenses, and to recognize the entities which have no cell-wall. Schwann investigated most successfully the nervous system, and his name will ever remain associated with it. He died at a ripe old age, having led an industrious, simple, and most useful life, and having lived to see himself the recipient, on the occasion of his jubilee, of distinguished honours on the part of the scientific world.

V.—*On Mounting Objects in Phosphorus, and in a Solution of Biniodide of Mercury and Iodide of Potassium.* By John Ware Stephenson, Vice-President R.M.S., F.R.A.S.

(*Read 11th January*, 1882.)

In the use of modern objectives having numerical apertures exceeding *unity*, or, in other words, exceeding the equivalent of 180° in air, it is absolutely essential, and this cannot be too strongly impressed, that the refractive index of the medium in which an object is mounted, shall at least equal the numerical aperture of the objective employed.

Hence it follows that air, having a refractive index of 1, is not a suitable medium in which to examine an object under an objective of which the numerical aperture is more than 1, say 1·25, or 1·47; the former being that of the first homogeneous immersion objective (made by Zeiss), and the latter that of the most recent production of Powell and Lealand.

For instance, water, having an index of 1·333, is a medium of sufficient power to develope the full aperture of the objective of N. A. 1·25; whilst Canada balsam, or any other medium having a refractive index exceeding 1·47, is necessary for the latter.

An object is literally mounted in air, only if a film of air intervene between it and the thin glass cover. If it adhere to the cover, the effect is the same as if it were half in air and half in glass, and if the aperture of the objective exceed unity, its effective aperture is reduced from a, to $\frac{1+a}{2}$, that is to say, one-half of the excess of aperture beyond unity, is, under these particular circumstances, entirely lost.

The problem then is, in all cases, to find some medium fulfilling the before-mentioned conditions, but at the same time such, that the difference in the refractive indices of the object and medium shall form a sufficiently strong image to give distinct vision, but on the other hand not so great as to render the object opaque.

In some preparations, however, the end in view is to render certain parts of the object very faintly visible, in order that other parts may become more visible by contrast. This is notably the case in preparations which have been injected or stained with some pigment, when colour alone is depended upon to depict the structure. We all know that such an object in spirit or water or alcohol is frequently too opaque for our purpose; the difference in the refractive indices of the material to be examined and medium employed is too great, and we, therefore, "*clear the object*," as it is called, by transferring it from pure spirit, with its low refractile power, to the higher one of oil of cloves, and finally into balsam; by so doing we have placed the object in a medium approximately of the same index as itself, we have optically got rid of the unstained portions, leaving the coloured parts more distinctly visible.

Muscular fibre is an illustration of the effect produced on the visibility of an object under these conditions. In water or glycerine (optically considered) it is well shown, because the difference of refractile power is sufficient to depict the structure and not so great as to obscure the view; but mounted in Canada balsam, in which the two indices are so much nearer equality (balsam being less than the muscular fibre), the image is so faint that we resort to polarized light, if it be necessary to examine it under such circumstances.

This, however, is a digression from the original scope of my observations, which were rather directed to the question of mounting when modern objectives of large aperture are employed.

I have pointed out that if an object adhere to the cover the utilized aperture is reduced to $\frac{1 + a}{2}$; but if it be mounted on the glass slip it is, for the purpose of our investigation, in the worst possible condition, as the effective aperture is reduced to something less than the equivalent 180° in air—very little less, it may be perhaps, but still, if a film of air intervene, its available aperture cannot be quite up to this limit.

If Nobert's 19th band were ruled on the slide, instead of on the cover, or, what is the same thing, if the plate were turned over and covered with a thin glass, so that a film of air, however thin, intervened, no objective that has ever been made, or I may say ever will be made, would be capable of making the lines *visible.*

The result would be vastly different, however, if Nobert's plate were mounted in some medium giving a difference of index sufficient to render the rulings visible; such a medium is a saturated solution of phosphorus in bisulphide of carbon; here the respective indices of the object and medium are, (if Nobert's lines are ruled on crown glass), about 1·52 and 2·1; the difference between these gives a greater degree of visibility than that of a diatom in air, the difference of the former being 0·58, and of the latter about 0·43.

So mounted, the resolving power on such rulings would be increased by more than 11 per cent. with the first homogeneous-immersion objective, and by more than 19 per cent. with Powell and Lealand's more recent production, so that the 19th band by no means represents the attainable limit of resolution, if such rulings are suitably mounted.

In mounting objects in phosphorus there are three points of vital importance:—

1. The object must be absolutely dry, or if moistened, it must be with a substance soluble in bisulphide of carbon.

2. The phosphorus must be introduced with the least possible exposure to the air, as phosphoric acid is otherwise very readily formed, and this ruins the preparation.

3. The solution of phosphorus must be perfectly clear and bright.

Of not much less importance is the necessity of having a vessel of water at hand, in order that the bibulous paper which has been used in the process, may be instantly submerged so as to prevent the danger of spontaneous combustion, and also to avoid the inhalation of fumes from the phosphorus which are prejudicial to health.

In the preparation of the solution a 2-drachm bottle without any contraction for the neck is employed. A filter of bibulous paper is formed, accurately to fit the bottle by folding the paper down and around a small ruler or other cylinder of wood, of such a size, that with the paper around it, it may fit tightly into the bottle, to the bottom of which it is forced, and the wood withdrawn. The filter is now moistened with a few drops of bisulphide of carbon, all excess beyond that which is necessary for this purpose being dashed out, and a piece of stick phosphorus, as pure as possible, and say $\frac{1}{4}$ or $\frac{3}{8}$ of an inch in length, dropped into the filter, and the bottle corked; the vapour from the bisulphide instantly acts upon the phosphorus, and in about half an hour or less it will be entirely dissolved, but still remaining in the filter. By taking a firm hold of the edge of the filter with a pair of forceps, and very slowly drawing it upwards, a partial vacuum is formed beneath the filter, and the pressure of the atmosphere on the surface of the solution forces the phosphorus through the paper, and the brilliant highly refracting fluid is seen at the bottom of the bottle. The filter now withdrawn must be instantly plunged in water for reasons already given.

The phosphorus being thus prepared, the mode of mounting is as follows. We will suppose the object to be diatoms, and of course adhering to the cover.

In the first place a ring, somewhat smaller than the thin glass cover, is formed on the slide in the usual way, using for the purpose a solution made of glue, mixed with a small quantity of honey, which preparation when cold should form a somewhat stiff jelly.

The thin cover is now placed on the glass slip, but being raised on one side by a piece of bristle or fine wire, it is only the opposite side which touches the glutinous ring, to which it adheres. The reason for tilting the cover will be seen hereafter.

The next step is the real mounting, which is effected by means of a pipette; this is made of glass tubing (say $\frac{1}{8}$ of an inch in external diameter), drawn out to a fine point at one end, the other more open end being capped with about an inch of indiarubber tubing, whipped on to make the joint air-tight, and the free end closed by a clump or plug or by any other means.

The pipette thus made is passed through a cork, so that the fine opening formed at the pointed end shall reach the bottom of the bottle or nearly so, and will therefore be beneath the surface of the phosphorus.

The indiarubber tube being squeezed, forces out some of the air contained in the pipette, and on relaxation of the pressure, the partial vacuum thus formed is occupied by a drop or perhaps two of the phosphorus.

The fine point of the pipette, which will generally be found free from any adhering phosphorus, is now introduced beneath, or close to, the edge of the tilted cover. The tube is squeezed, and the phosphorus thus forced beneath the cover instantly fills up the space between it and the slide. It will not fail to be observed that the whole aim has been to expose the minimum surface of phosphorus to the oxygen of the atmosphere; if phosphoric acid is formed, either by fuming and condensation on the thin cover, or on the exposed surface of the phosphorus the object will, as previously stated, be spoilt. Should this operation have been successfully accomplished—and there is no difficulty in doing it—all risk is over; the cover is gently pressed down and the mount closed by passing some of the warm preparation of glue around it.

When this has set pretty securely, which will be in about half an hour, it will probably be found that some of the redundant phosphorus has escaped from beneath the cover; this is conveniently removed by a piece of blotting paper wetted with bisulphide of carbon; it must be applied with a pair of forceps, special care being taken not to touch the paper so used with the fingers, and it must be plunged into water immediately after using, as it will otherwise take fire spontaneously, at ordinary temperatures, in the course of a minute or two. Phosphorus left in contact with glass does not appear to do this; at the same time it must not be forgotten that noxious fumes are always given off by phosphorus when exposed to the air, and it ought therefore to be removed.

As it is possible, notwithstanding every precaution, that some phosphorus may accidentally get on the fingers, it is desirable to have a small quantity of olive oil, as well as an oiled rag close at hand. Phosphorus is very soluble in olive oil, and as the solution is incombustible (spontaneously) an instant application removes the danger. It may seem that this risk has been too much dwelt upon, but as a burn from phosphorus is frequently very severe, it does not appear to the writer to be inopportune to urge the point. The slides may now be put aside for a day or two, when they can be finally completed by two or three successive coatings of gold size, after the first of which, any superfluous glue should be removed with water and a camel-hair brush, and "to make assurance doubly sure" a ring of sealing-wax (shellac) varnish after the last coating of gold size may well be added.

The slides thus prepared appear to keep perfectly well, as one of *P. formosum* which I mounted nine years ago and exhibited here on the 4th June, 1873, still remains unchanged; but it is fair to say, that having been during that period in my cabinet, it has had little exposure to daylight.

In addition to the increase of visibility there is another point of interest in the use of phosphorus. It was pointed out by Professor Abbe in our last volume, pp. 689 and 832, that depth of vision $= n\left(\frac{L^2}{N^2}\lambda + \frac{L}{N}\frac{\omega}{a}\right)$, from which formula it is obvious that the depth of vision (on which stereoscopic vision depends) increases in the same ratio as the refractive index (n) of the mounting medium. Hence it follows that the stereoscopic effect of phosphorus, with its index of 2·1, is more than double that of the same object mounted in air ($n = 1$), and it is to this circumstance that the stereoscopic appearance of the scales of *Machilis maritimus* and *Tomocerus plumbeus* under a $\frac{1}{25}$ is to a great extent due.

There is now another fluid to which it is very desirable I should again draw attention, and that is a solution of biniodide of mercury and iodide of potassium in distilled water. This is very easily prepared by adding the two salts to the water until each shall be in excess; when this point of saturation has been reached the liquid will be found to have a refractive index of 1·68, by far the highest aqueous solution known to me. With this fluid there is no difficulty or danger (apart from its poisonous nature) whatever, either in mounting or preparing. Its advantages from an optical point of view are considerable, and it may be used of any strength: commencing with pure water, with a refractive index of 1·33, we can go on progressively to 1·465, which represents glycerine, still on to 1·54 (Canada balsam), again onwards to 1·624, which represents bisulphide of carbon, to 1·658 which represents the monobromide of naphthaline, to 1·662 the equivalent of a solution of sulphur in bisulphide of carbon, until, undiluted, it finally reaches its own maximum of 1·680;—thus we have the representatives of all these media and an infinite number of others in this one fluid.

As mentioned at our last meeting, it is easily sealed with white wax, and I have found the following a simple and effective plan of doing so.

The glass slip having been heated on the turntable, a wax cell is formed by touching its surface with a piece of white wax; in the centre of the circle thus formed, when cold, a drop of the solution is placed, and on this the thin glass cover.

The cover can be fixed by heating an ordinary gun-punch (or other metallic ring) to the melting-point of wax, and placing the cutting edge on its upper surface; the weight of the punch as the wax melts soon adjusts the cover in its place, and when cold the excluded solution is cleaned off.

Two or three coatings of gold size and one of shellac finally fix it, as in the case of the phosphorus.

This fluid is so dense, its specific gravity being 3·02 (as kindly determined for me by Mr. C. G. Stewart, of St. Thomas's Hospital), that almost any microscopic object will float on its surface; this is the case with diatoms, for example, and consequently any which may become detached will still be found in contact with the cover, and may thus possibly present themselves under different aspects.

Its refractive index being 1·68, the visibility of diatoms, when mounted in it, is represented by the number 25 as compared with 11 in Canada balsam—in other words the image is nearly $2\frac{1}{2}$ times as strong; this is no doubt very inferior to that yielded by phosphorus, in which the strength of the image is 6 times as great as in balsam, but nevertheless, *Amphipleura pellucida* is very easily resolved in it, and on looking over a slide, mounted last evening, not one valve was found (and they were delicately marked), which was not resolved without any trouble under Zeiss' homogeneous $\frac{1}{8}$.

For muscular fibre, on the other hand, a strong solution is not suitable, since the high refractive power of the object approaches that of the medium, and the resulting image is consequently very faint, but as every other medium of a lower index than 1·68 can, by dilution, be represented by it, any degree of visibility down to that yielded by water can be obtained.

For marine animals a weak solution is probably well adapted, as about a 1 per cent. solution (5 minims to the ounce) will give the specific gravity of sea-water, with no appreciable difference in the refractive index; and the same strength appears suitable for some vegetables. How far the colours of these may fade can only be determined by time, but a limited experience shows that the colouring matter of the petals of flowers is dissolved out, although the action on chlorophyll appears in some cases to be small, after two or three weeks' exposure.

Although the dispersive power of a mounting medium is not of importance, it may be mentioned as a matter of interest, that the dispersive power of this fluid is excessively great, being equal to 0·05483 (that of very dense flint glass, $n = 1\cdot802$, being only 0·03287), and the extension of the blue in comparison with the red, much greater than that of any other known substance, as I am informed by Professor Abbe, who kindly determined these points with his Refractometer from a sample sent by me for his examination.

Being an aqueous and highly antiseptic fluid, no transfer from it to another medium is required, but I am unable to say what its effect may be on stained preparations, possibly unfavourable, but on this point as well as on its chemical effect on different structures I am unable to express an opinion at present. On the whole, however, I venture to think that for the above and other reasons it is destined to become of great importance in the microscopy of the future.

VI.—*On the Threads of Spiders' Webs.*

By John Anthony, M.D., F.R.M.S., &c.

(*Read* 11*th January*, 1882.)

In the course of observations on the habits of spiders, and more particularly of those which construct geometrical webs, an idea occurred, that by management, the *Epeira Diadema*—one of the largest of our garden spiders—could be made to spin his thread in such a way, as to cause the whole, or the greater part of the strands composing this minute cord or cable, to remain separate, instead of coalescing, and so forming the well-known "thread" by which the diadem garden spider is so often seen suspended. The experiment answered perfectly, and the results were so full of interest for the student of natural history, as to cause me to describe carefully the means I employed, so that any one may be able to repeat the experiment, and arrange fairly permanent preparations of the parts making up the spider's thread for deliberate examination under the Microscope; premising, that so far as is known, the same method will be equally successful with any of the web-spinning spiders.

A fine *Epeira Diadema*, suspended as usual by his thread, being available, six ordinary slips of microscopic glass were placed in readiness to have the spider's thread wound upon them as it was spun. The idea acted on was, that the threads issuing from the hundreds of "spinning-tubes" on the various papillæ or teats, known as "spinnerets," *must* travel for an appreciable distance ere they coalesced in a more or less hardened but still glutinous condition, to make up what we call in popular language "the spider's thread," and that, therefore, these ultimate fibrils, though numbered by hundreds, and of exquisite fineness, could assuredly be intercepted at a point sufficiently near the spinnerets to cause the strands to remain separate on the surface of the glass slip, instead of coalescing. The slip was then made to catch the Epeira thread, winding the line so as to come near the body of the spider, who not liking the look of things, lowered himself, as was expected, rapidly towards the ground to escape, and was as rapidly wound up, and raised into mid-air.

Now, as spiders do not like to part with spinning material if they can avoid it, and as Epeira evidently got no nearer the ground, he paused in his "paying out" of line to think a little, and he did not cut his thread, inasmuch as a fall from that height was not to be risked; so, as he was now pretty steady, another slip was brought into operation, the edge of it placed close under the spinnerets, or in the actual position of the spider, rather above them, and once having got adhesion of these issuing strands while they were quite separate, it was manifest that with due precaution in winding up, the strands need not be allowed to approximate to form the rope; so wind after wind, the exquisitely delicate floss-silk-like strands were stretched over the surface of the glass slip—evident to the naked eye by an iridescent appearance. These strands being directly across the slip at right angles to its long axis, would be very close together, even if not often touching each other, so on another slip a variation was made, by tilting the slip sideways as it was turned to receive the strands; the brush of minute filaments, which had a tendency to approximate, was now made to diverge, and spread out on the surface of the slip into a sort of fan-shape, and this arrangement may be seen on the slide under the Microscope. From the very small portion visible under a magnifying power, the effect is, that the minute filaments are parallel, like harp-strings, to which they bear no small resemblance, but inspection will show that this mass of filaments has by the device named been rendered divergent.

There was now no difficulty in covering all the remaining slips with these separated components of the spider's thread, and, as might be expected, these slips showed, on after examination under the Microscope, every variety of combination by which the infinitely small filaments combined to make up a manifestly substantial cable; so that, taking the number of teats bearing the ordinary spinning-tubes to be four, there would be seen the four strands making up the cable, and in another part the ultimate filaments of which these strands were composed.

I am glad all these things can be shown on the slip under the Microscope; they look exquisitely beautiful by any mode of lighting, but under dark-ground illumination, the effect of hundreds of silver wires of marvellous delicacy is charming beyond expression.

It may be stated that at the end of the experiment, Epeira, whose patience had been rather severely taxed, was let down near to the ground, when, the haste with which he severed his thread and scampered off, was evidence that his quietude in mid-air was more a matter of prudence than inclination.

An identical mode of obtaining a division of the thread was employed in the case of a very small spider which has the habit of lowering itself from ceilings, the trivial name of which is "Money Spider." The results obtained were very similar, the thread was seen divided into its component parts, but how many parts it would be difficult to say, for the difficulty now became to find these ultimate filaments; it was evident that they were there, but so fine as to require a careful illumination and a fine high-power objective, with very careful touches of the "fine adjustment," to make them out, and then they looked very much like very finely ruled micrometer lines irregularly spaced.

It is rather important to notice one portion of the conclusions arrived at from these experiments, and that is, that in reckoning up the number of filaments spun by Diadema, and going to make up the cable, the count always came below 200. Now this would appear quite insufficient as a product of the spinning-tubes, which in a fine preparation I have of the spinnerets by Bourgogne, certainly exceed 1000 in number; so it would seem we have to fall back upon the conclusion, that either all the spinnerets are not in action at the same time, or, that a considerable proportion of the spinning-tubes, which have apparently some differences in structure, have also a different function to perform, such as cross lines of the geometric web and "bead globules." This is mere surmise, but the fact of the small number of ultimate filaments in relation to spinning-tubes remains.

A description of the mechanism of the spinning apparatus would make this paper too long. It would form the basis of a future communication, or the materials are at the service of any microscopist who wishes to work out the subject.

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.

Germinal Layers and Early Development of the Mole.†—Mr. W. Heape gives the results of investigations upon the origin and formation of the germinal layers in mammals, more especially in the mole (*Talpa Europœa*), as follows:—

1. The *epiblast* of the blastodermic vesicle owes its origin as well to the inner mass of segmentation-spheres as to the outer layer of segments. It appears to originate in two ways:—

a. In the early stages of development (in the mole), probably by the cells of the inner mass being directly transformed into part of the wall of the blastodermic vesicle.

b. In a later stage (mole and rabbit), by the transformation of the rounded cells of the inner mass into a plate of columnar cells, which joins the part of the outer layer immediately above it to form the epiblast plate of the embryonic area.

2. The *mesoblast* in the mole is formed in two portions:—

a. A large portion, which has its origin in the primitive streak.

b. A smaller portion, which is derived from the hypoblast situated in front of the primitive streak.

The author was unable to distinguish where the latter, or hypoblastic mesoblast, comes into contact with the mesoblast of the primitive streak, and what part these respective layers take in the future development of the embryo.

3. A *neurenteric canal* is present in the mole similar to that formed in other types of Vertebrata, first appearing as a pit at the anterior end of the primitive streak, while in later stages it perforates the floor of the hinder end of the medullary groove.

* 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.")

† Proc. Roy. Soc., xxxiii. (1881) pp. 190–8.

He also found in a seven days' rabbit embryo a rudimentary neurenteric canal, in the form of a shallow pit, in the epiblast at the front end of the primitive streak.

4. The *notochord* is formed of an axial strip of cells, which underlies the epiblast of the medullary groove, and which either never become divided into mesoblast and hypoblast, or in which such a division, if it does take place (as appears not impossible), is very soon lost. This strip of cells is originally continuous laterally with both mesoblast and hypoblast, but as the lateral mesoblast becomes converted into definite vertebral plates, the connection is lost.

There can, it is believed, be no doubt of the connection of the lateral hypoblast and mesoblast with the notochordal cells in the mole; in the rabbit, Mr. Heape is inclined to believe that a similar connection is present, but his evidence on this point is not yet conclusive.

Development of Amphioxus.*—In this paper Dr. B. Hatschek deals in detail with the earlier stages only. In describing his method of study, he says that he has always endeavoured to study in the living object all that it would allow. For the preservation of specimens in the cleavage stage Kleinenberg's fluid was found useful; and coloration was effected by osmic acid: the former was not adapted for the gastrula-stage, when osmic acid was used. The earlier stages of segmentation require a treatment different to the later, on account of the large amount of yolk then present; an addition of $\frac{1}{2}$ per cent. osmic acid to the sea-water killed the embryo in the earlier stages, when no colouring matter was employed; in the later stages Beale's solution or picrocarmine were found useful.

Oviposition is seen to be markedly dependent on the weather and the time of day; the generative products are most certainly expelled by the mouth. Development breaks up into two well-marked stages, the one embryonic, when it is effected at the cost of the nutrient material contained in the egg, and is very rapid. At the close of this period the mouth is developed, and the first gill-cleft. The larva now begins to feed itself, its cells contain transparent protoplasm, and the developmental processes are very much slower.

While giving a general support to Kowalevsky's classical account of the earlier stages, the author finds that the ova are generally quite isolated. The five fat-bodies of the Russian author are regarded as yolk-granules; the spermatozoa would appear to always enter at the vegetative pole. The cleavage was found to be unequal, the differences between the two poles being well marked. There is a pause of about an hour between the formation of the first and of the second groove.

At the blastula-stage we find the investing cells taking on an epithelial character, till there is formed a general outer layer, enclosing a cavity. This simple epithelium forms the substratum for the later developmental processes; all the essential organs are formed by foldings or outgrowths from it. Bilateral symmetry is obvious at a very early period; the blastopore appears to close from before back-

* Arbeit. Zool. Inst. Univ. Wien (Claus) iv. (1881) pp. 1–89 (9 pls.).

wards. The lower layer, which goes to form the endoderm, does not correspond to more than one-third of the blastula; this undergoes invagination, the fluid of the cleavage cavity becomes absorbed, and bilateral symmetry soon becomes well marked.

In the "third period" the primitive segments, the nervous system, and the notochord begin to be apparent; the remnant of the blastopore persists as an opening between the enteric cavity and the nerve-tube, representing the typical neuro-enteric canal. Contemporaneously with the development of the nerve-tube, the mesoderm developes the primitive segments; two lateral longitudinal folds arise in the dorsal portion of the endoderm, and represent the rudiments of the mesoderm. The cavities of the primitive segments are diverticula from the archenteric cavity.

After describing these points in detail, the author makes some observations on the mechanics of the developmental process. All those described are referable to foldings, solutions of continuity, or outgrowths. What are the causes of the first? Some are due to contractions of the protoplasm, to active changes of form, while others are referable to growth; in the others we have to note as an important factor differences in growth-energy. Active changes are limited to short periods, and the formation of the dorsal groove is an example; with this the development of the mesodermal folds has a close mechanical connection. Growth is more energetic in the anterior regions. The prime cause of the development of the mesodermal folds would appear to be the greater superficial extension of the endoderm in the dorsal region; so, again, the formation of the first primitive segment commences by a flattening of the anteriorly placed endodermal cells; the cells pushed back are folded transversely, and so give rise to the first primitive segment.

In the stage in which there are seven primitive segments there appear in front of them two dorsal folds of the endoderm; these become more and more marked, and give rise to two blind sacs, which are at first bilaterally symmetrical, and are placed at the anterior end of the enteric canal. About this time the epithelial cells become for the most part much more flattened; and the dissolution of the yolk-granules is almost completed.

The fourth stage is the period of histological differentiation, muscles become apparent, the notochord undergoes histological differentiation, and fibrous cords appear in the medullary tube. At the same time the larva alters greatly in form, becomes elongated and compressed, and takes on generally a piscine character. The increase in the number of primitive segments goes on but slowly, but what are formed gradually fuse in the ventral median line. Each muscle-cell has at first only a single fibril, and there is no indication of segmentation; we may say, indeed, that a row of cells secretes a common fibril, which is continuous throughout the length of the body. The author cannot agree with Kowalevsky in thinking that there is any special chordal sheath, and he does not see here any difference from what obtains generally throughout the Vertebrata in the histological differentiation of the notochord; small vacuoles appear within its cells, grow in size and diminish in number, till at last they are so extensive that nothing but thin partitions intervene between them.

The anterior endodermal sacs undergo development asymmetrically; they become shut off from the exterior, the one on the right increases in size, while the left undergoes no change, till at the commencement of larval life it opens on the left side of the body by a small orifice. This is the special organ of larval life, as described by Kowalevsky. Another organ, the club-shaped gland, is also developed from the exterior. Formed in the region of the first metamere, it becomes towards the end of embryonic life shut off from the exterior. It now lies chiefly on the right side, but extends transversely across the enteric canal, and opens at the outer margin of the mouth; part of it becomes glandular, and the rest forms an efferent duct. The external epithelium is still ciliated, but is now generally thinner.

In the fifth period, the last here described, those changes occur which enable the embryo to pass into the larva. A number of orifices are now formed, the mouth and the first gill-cleft, the orifice of the ciliated organ (or left endodermal sac), the club-shaped gland, and the anus. The body meanwhile increases in length, fresh segments being formed, a number of strong motile flagella may be seen to be developed from the cells, and all the tissues of the body are now formed of transparent protoplasm.

B. INVERTEBRATA.

Fossil Organisms in Meteorites.*—In his own abstract of his detailed memoir on this subject, C. Vogt says, "I have endeavoured to discover whether the bodies to which Dr. O. Hahn calls attention,† really have the structural characters of the organisms to which he has assigned them.

"By a detailed comparison of the living and fossil sponges with the supposed sponges of meteorites, I am able to show that there is no resemblance in microscopical structure between them. I prove, by the same method, that neither the corals nor the Crinoids which Hahn believes that he has discovered in the meteorites have anything in their microscopic structure in common with living or fossil corals or Crinoids. I further refute the theory, which may be described as at least singular, according to which the corals are only an evolutional development of the sponges, and Crinoids a product of the further evolution of the corals.

"I demonstrate the fact that, in order to obtain the completest possible knowledge of the structure of the chondrites" (the species of meteorites from which the specimens were prepared) "we must resort to check-experiments, based on dissociation of the constituent elements either by chemical reagents (as acids and caustic potash) or by the mechanical operation of grinding to the finest possible sections. The fragments which are obtained in this way should be studied by

* Comptes Rendus, xciii. (1881) pp. 1166–8.
† See this Journal, i. (1881) pp. 722–4.

polarized and not merely by ordinary light. The check-experiments show with the greatest conclusiveness that the chondrites are entirely composed of crystalline pieces, variously disposed, and that organic structure is quite absent from them.

"I then pass on to compare the structure found in the chondrites with those of artificial products which have been brought to the knowledge of the Academy by MM. Daubrée and Meunier. I prove, by camera drawings, that various crystalline forms which may be seen in meteorites were long since reproduced by M. Daubrée, and that the incrustations of enstatite made by M. Meunier exhibit under the Microscope the same radiating and jointed arrangement as the so-called organisms of Hahn. Finally, I demonstrate that the columnar formation which is only revealed by the use of the polariscope and by shaking, and which may be seen in certain chondrites, is also found in rocks belonging to the globe under the same conditions.

"The comparative method of study which I have adopted, aided by drawings made from nature, leads me to the following conclusions:—(1) The alleged organisms of meteorites (chondrites) have no existence; what have been described and figured as such are made up of crystalline bodies, entirely inorganic. (2) None of these alleged organisms have the microscopical structure which belongs to the real organisms with which they have been associated; in particular, the so-called sponges do not exhibit the structure of the living or fossil sponges, nor the corals the structure of zoophytes or Anthozoa, nor the Crinoids that of the known forms of Crinoids. (3) The structure which has been observed is either due to the presence of an opaque encrusting substance, or is the result of optical illusions caused by an incomplete method of microscopical examination. (4) The study of thin sections, obtained by grinding, carried only up to a certain point, is insufficient to elucidate the structure of the chrondrites. This method of investigation must be controlled by observations made on sections reduced to an extreme degree of thinness, as well as by the examination of chondrites dissociated by acids and caustic potash. (5) The check-experiments show conclusively that all the chondrites are composed of transparent crystalline masses, grouped in different ways, but most usually in the form of miniature columns or ramified tufts radiating from a centre. The interstices, fracture-cavities, and gaps between these masses are filled with an opaque incrusting material, a considerable part of which resists the action of acids, and both simulates septa and has definite shape and other peculiarities which are attributed to organic structures. (6) The tufts which make up the chrondrites are identical in their form and in the manner in which the crystalline pieces composing them are arranged, with the tufts of artificial enstatite, obtained by Meunier in his experiments; just as the globular masses of crystals formed during the same experiments, are analogous in their manner of grouping to chondrites of ramifying and jointed structure. (7) In certain finely striated chondrites, a rectilinear columnar arrangement may be seen, identical with the structure of certain terrestrial enstatites (*Schifferfels* of Baste, in the Harz). (8) The greater number of chondrites contain a quantity of groups of enstatite crystals, identical in their mode of grouping, their form, and structure with those obtained by M. Daubrée by fusing peridote with wrought iron (*fer doux*). (9) Deducting the pulverulent and metallic substances, and the uncrystallized encrusting materials, ordinary meteorites consist only of crystalline elements united to form chondrites; this is proved by disintegrating them by rubbing or by the use of acids.

Red Pigment of Invertebrates (Tetronerythrine).* — At the coast it may readily be observed that a red coloration is very common among invertebrate animals, and even fishes. And according to C. Mereschkowsky, even the animals coloured yellow, brown, green, and black, have always a scarlet red pigment, which in their case is hidden by others. The red pigment, he finds, is always the same substance, viz. that known as *tetronerythrine;* he has verified its presence in one hundred and four species (invertebrates and fishes). The question arises, what is the physiological *rôle* of this widely expanded substance? The author finds evidence that it corresponds to hæmoglobin in higher animals: serving for cutaneous respiration by virtue of its great affinity for oxygen. Thus, as regards distribution in organs, wherever oxygen has to be largely consumed by the tissues, there tetronerythrine is abundant. This is illustrated by skin tissues in immediate contact with the oxygen of the water; by the organs of respiration (e. g. in sedentary Annelids the tetronerythrine is concentrated in the branchiæ, the rest of the body having only traces); by muscles, and such an organ as the muscular foot of Lamellibranchiates. Next, as to distribution in the animal kingdom: sedentary animals are often redder, and have more tetronerythrine than errant animals; the latter which, by constant change of place, are always in water holding plenty of oxygen, not having the same need of a special substance to increase the oxygen absorbed by the tissues. Then the fact that tetronerythrine occurs by preference in invertebrates, where hæmoglobin is wanting (and only exceptionally in higher animals), points to similarity of function in these substances. It is further pointed out that animals provided with yellow cells (parasitic algæ), which are proved to produce free oxygen in the tissues, are without tetronerythrine, or have very little of it.

Mollusca.

Maturation, Fecundation and Segmentation of Limax campestris.† —In this remarkable contribution to embryology, E. L. Mark deals in the first sixty pages with his own observations; the rest of the paper falls under the head of bibliography, and we have nearly three hundred pages devoted to a consideration first of the egg-envelopes and yolk of *Limax*, and secondly of a review of maturation, fecundation, and cell-division; asters, quiescent nuclei, and nuclei in division are successively taken in review; and for the last, tissues as well as plants are examined; the paper concludes with theoretical considerations and conclusions, in which attention is drawn to such important points as the promorphology of the ovum, asters, origin of nuclei, and

* Comptes Rendus, xciii. (1881) pp. 1029–32; Nature, xxv. (1882) p. 276.
† Bull. Mus. Comp. Zool., vi., No. 12 (1881) pp. 173–625 (5 pls.).

polar globules, among others. An alphabetical bibliographical list, and a list of the authors cited in the text aids the reader in his study of the work.

The eggs, usually found in clusters of about a dozen, vary in their mode of packing, and in their arrangement in the cracks of earth which shelter them; their more or less plump appearance depends on hygrometric conditions, and they are not always of the same form. When first deposited, the yolk is much denser than the surrounding albumen, but it is not provided with any proper vitelline membrane.

At first the changes occur very slowly, but soon they succeed one another more rapidly. First one and then the second polar globule appears, and, as a rule the latter is somewhat smaller. In dealing with the formation of the female pronucleus, the author points out that it constantly remains near the surface of the vitellus; its diameter may eventually attain one-fourth the diameter of the whole vitellus, or, in some cases, one-third. When treated with acetic acid, the female pronucleus is modified in shape by the formation of a number of deep wrinkles and folds; when with osmic acid (and subsequent staining in carmine), it has a delicate and even outline, and its form is spherical, pyriform, or oviform. Soon after extrusion, a number of small ovoid bodies of high refractive power are to be found near the vitellus, presenting a filamentous appearance in some cases; they are, doubtless, all spermatozoa; they may be present in great quantities, and even form "trains" through different parts of the albumen. In one case an undulating membrane was noted in a spermatozoon.

After dealing with the characters of the male pronucleus and its history, the author passes to cleavage; here he finds that the first cleavage nucleus does not have a morphological existence; this is explained by assuming that the acceleration at this stage of the ontogeny is so great that the division of this future structure is begun before it has an actual independent existence. He is further of opinion that a differentiation commences in the superficial portion of the yolk, which is the first step toward the formation of a cell-membrane, and that this differentiation is proportional to the advance of cleavage.

It is impossible to enter into the details of the elaborate account of previous naturalists' observations which form the great bulk of this communication, which was apparently in the press before the publication of Mr. Balfour's systematic treatise.

Kidney of Chiton.*—Mr. A. Sedgwick gives an account of the structure of the kidney of *Chiton*, which is a paired gland constructed on the type always found in molluscan renal organs. It consists of—

1. A duct opening to the exterior in the pallial groove behind the generative opening, and internally into the pericardium.
2. Glandular cæca opening into this duct.

The duct may be described as consisting of three parts:—(1) The part into which the glandular cæca of the kidney open. This

* Proc. Roy. Soc., xxxiii. (1882) pp. 121-7 (2 figs.).

part is open to the exterior behind. In front it bends round, and runs backwards to about the level of the 5th shell plate, where it changes its character, and is continuous with (2) a duct containing brown colouring matter in the columnar cells lining it, and receiving no glandular cæca. This part extends back to the level of the last gill, where it turns outwards, and becomes continuous with (3) a part running forward for a short distance close to the lateral nerve, and lined by large ciliated columnar cells. This opens in front at the level of the penultimate gill into the pericardium. The author expected to find the communication between the two parts of the renal duct behind, in the region of the bladder, and for some time was puzzled at not finding it. Mr. Balfour however suggested that the communication might possibly be found in front, reasoning from the analogy of the structure of the kidney in other Mollusca, and on examining the anterior part more carefully, the two parts of the gland were found to be communicating.

Morphology of Neomenia.*—Messrs. A. Kowalevsky and A. F. Marion believe they have made the somewhat remarkable discovery that all naturalists who have examined this form have mistaken the posterior for the anterior end. They are enabled to show that the "lateral glands" of Tullberg are salivary glands, and that the organ called the radula is really the penis. The description of the present writers is in accordance with that of *Proneomenia* as lately given by A. A. W. Hubrecht; † but we reserve details till the publication of their fuller paper.

In another paper ‡ Hubrecht affirms his belief that it is the authors and not previous investigators who have misunderstood the matter.

Molluscoida.

Organization and Development of the Ascidians.§—A proper body-cavity in the Ascidians has been found by E. van Beneden to exist only in the larvæ. The species chiefly examined were *Phallusia mentula*, *P. mamillata*, *Ciona intestinalis*, *Perophora listeri* and *Clavellina Rissoana.*

The larval mesoderm is found to consist of a right and a left lamina, derived from the primitive endoderm, and limited to the posterior part of the body. Each of these plates is divided into a posterior portion, formed of a single layer of cells, and giving rise to the muscle-cells of the tail, and an anterior one, which in *Perophora* and *Clavellina* is bilaminar and encloses a cleft opening into the alimentary canal and roofed in above by the chorda dorsalis.

At a later period the anterior mesodermic cells lose their epithelial character, acquiring that of the adult blood-corpuscle, and becoming distributed to the epiblast, the central nervous system, and the hypoblast of the alimentary tract. A similar change comes over the endodermic cells of the floor of the neuro-intestinal canal, and the scattered cells give rise to the blood-corpuscles, the connective tissue, the body-

* Zool. Anzeig., iv. (1882) pp. 61–4. † This Journal, *ante*, p. 31.
‡ Ibid., pp. 84–6. § Comptes Rendus, xcii. (1881) pp. 1238–41.

muscles, the pericardium, and the sexual organs. In the bud of *Perophora* all these parts arise from the blood-corpuscles contained between the epi- and hypoblast.

In the adult of *Perophora* the wall of the heart is unilaminar; and the protoplasm of the deeper parts of its constituent cells takes on the structure of muscular fibrils. There is no cardiac endothelium. The wall of the heart is only a continuation of the visceral fold of the pericardium. This comes about from the fact that the mass of mesodermic cells from which the pericardium is developed is bilaminar, and a cavity appears between the laminæ, forming the pericardiac cavity; the inner lamina encloses a chamber which fills with corpuscles, and it becomes the wall of the heart.

In the primitive mass of mesodermic cells destined to form the sexual organs an excentric cavity appears, becoming the *sexual vesicle*; this divides into an exterior, female, and an interior, male portion; both are hollow and open into a long common tube formed of flat cells, which lies between the intestine and the gastro-œsophageal part of the alimentary canal, ending blindly at each extremity. This tube by growth becomes folded on itself, and its external section becomes the oviduct, its inner one the vas deferens; the posterior inflated end of the latter becomes the testis, which, single at first, becomes multilobate. The ovary arises by the conversion into germinal epithelium of the flattened epithelium of the posterior end of the oviduct; the primitive ova thus formed become imbedded in the investing connective tissue and form a follicular mass. The ovum falls into the oviduct when mature. At first the vas deferens opens into the oviduct, but when the cæcal anterior end of the latter opens into the cloaca, the opening of the former reaches the cloaca also and becomes independent. The strong analogies which exist between the development of the pericardium and the sexual vesicle show that if the pericardiac chamber is homologous with that of Vertebrata, that of the sexual organs corresponds with the abdominal cavity.

The body-cavity (" enterocele ") of the larva completely disappears, for the epithelial cells which line it expand into a " blastocele," and then form a continuous mass, or mesenchyme. There is thus no radical distinction between the mesoderm and mesenchyme as held by the brothers Hertwig to be the case. In their structural characters and in the mode in which the nerves terminate in them, the muscles of the adult approach the smooth muscular tissue of Vertebrata, but those of the heart are peculiar in consisting of parallel fibrils placed in the deeper parts of epithelial cells.

It follows from the above facts that the mesenchyme has not always the same origin or the same anatomical importance in the animal kingdom. In the Cœlenterata and Vertebrata it is a *primitive* mesenchyme, as being produced by contact with an epithelium; in the Ascidians it is *secondary*, for it results from the dissociation of the cellular elements of an epithelium (the original mesoderm). The muscular fibres which originate from cells of the mesenchyme appear to be always fibre-cells, whether the mesenchyme is primitive or secondary.

"Challenger" Ascidians (Culeolus).*—Dr. W. A. Herdmann forms the genus *Culeolus* for a series of six new species of pedunculated simple Ascidians, belonging to the family Cynthiidæ, and having several anatomical peculiarities distinguishing them from all hitherto described genera. The nearest ally of *Culeolus* is *Boltenia*, and these two genera have been placed together as a sub-family, the Bolteninæ, characterized as Cynthiidæ which have the body pedunculated, the tentacles compound, and the branchial sac with more than four folds on each side.

Culeolus is distinguished from *Boltenia* by its remarkable branchial sac, and by the external character that its branchial aperture is triangular, and its atrial aperture bilabiate, while in *Boltenia* both apertures are four-lobed. The branchial sac is in all respects, except the possession of a certain number of longitudinal folds on each side, the simplest form known among simple Ascidians. It may be described as a simple network, formed by two series of vessels crossing at right angles and communicating at the points of intersection. In its vessels is found an extensively developed system of calcareous spicules of considerable but varying size, often much ramified, and having a very characteristic appearance from their gentle curves and blunt ends.

One of the species, *C. murrayi*, is described in detail, anatomical and histological, while the other five are not so fully treated, but the different systems in each are compared with those of the type, and the modifications are pointed out.

All the species are from upwards of 600 fathoms; five are from over 1000 fathoms, four from over 1500, and two from upwards of 2000 fathoms. They all belong to the abyssal fauna. It is noteworthy that these six species, the only deep water Bolteninæ, all belong to one genus, notwithstanding their wide distribution in space, one species being from the North Atlantic, two from the Southern Ocean, one from the South Pacific, one from the North Pacific, and one from the centre of the Pacific Ocean on the equator.

Embryonic Membranes of the Salpidæ.†—Dr. J. Barrois finds that some of the discrepancies between the accounts of Salensky and Todaro, which appeared almost simultaneously, are to be ascribed to the extreme diversity in the developmental history of the members of this group of the Tunicata; and he is able to speak to the correctness of their accounts of the different forms examined by them.

The first species now described is *Salpa maxima*, and we see that much that is true of it is true of other forms also. The appendages are either extra-fœtal or embryonic. When the ovum has reached its definite position its follicle has the form of a rounded vesicle, with three thick walls, and is attached to the base of a shallow depression in the wall of the branchial sac; segmentation is now somewhat advanced. The follicle becomes oval, and the depression becomes converted into a cul-de-sac, which projects considerably into the interior of the respiratory cavity; in this cul-de-sac the follicle is

* Proc. Roy. Soc. xxxiii. (1882) pp. 104–6 (1 fig.) (Abstract only).
† Journ. Anat. et Phys. (Robin) xvii. (1881) pp. 455–98 (2 pls.).

completely lodged. This process becomes more and more marked, and the egg begins to exhibit a segmentation cavity. Two grooves appear, and divide the cul-de-sac into three portions; as they deepen, the sac gets the form of an irregular mass, and the median portion gives rise to the peripheral layer (placental membrane, Todaro) of the placenta; in the next stage the lower wall of the follicle increases in size and gives rise to a mass of several rows of cells, which will go to form part of the placenta. The fold formed from the inferior divisions of the sac forms two layers of the circular fold, which is destined to cover the whole of the embryo (*caduca externa*, Todaro). During this process the superior division of the cul-de-sac has become much more completely attached to the upper portion of the follicle. The circular fold grows more and more over the embryo.

The embryonic appendages are thus developed: the outer layer of the embryo becomes applied to the inner face of the follicle, its lower portion, with which there is connected the mass formed by the internal layer, separates from this follicle, and so gives rise to the placental cavity; that portion of the outer layer which invests it is the *fœtal placenta*, the rest of the embryo forms the endoderm and apparently the rudimentary ectoderm. A little later the young *Salpa* becomes invested in a single layer which forms its skin, the endodermic mass becomes completely detached from the fœtal placenta, and forms a nucleus around which the principal organs are developed. The fœtal placenta unites with the placental membrane to form the complete placenta, a third layer in which is formed from the mass of several rows of cells, already mentioned. The fœtal placenta increases in size and then undergoes a retrograde development; thus the structure of this part is simplified. The remaining stages are simpler.

There are, then, three parts concerned in the formation of the embryo and its appendages; two, the follicle and an expansion of the wall of the branchial sac, are developed from the mother; the third is formed from the egg. The upper portion of the primitive cul-de-sac forms the outer wall of the primitive incubation-cavity, the fold at the base bounds the definite uterine cavity, while the median portion gives rise to the placental membrane. From the ovum the embryo proper and the fœtal membrane are developed. The author thinks that the so-called placental membrane has really no placental function, but rather serves to keep the incubation-sac in its place in the middle of the great uterine cavity. Reduced to its simplest terms, we may say that the mother furnishes two incubatory pouches, connected by a membrane which maintains the first within the second pouch, and the maternal placenta; while to the embryo there is to be ascribed a simple expansion, which, like the allantois of the Mammalia, is destined to form the central portion of the placenta.

Modifications of the Avicularia in Bryozoa.*—Mr. T. Hincks considers that there can be no reasonable doubt that the vibraculum is a derivative from the avicularium and not an independent modifica-

* Ann. and Mag. Nat. Hist., ix. (1882) pp. 20–5 (4 figs.).

tion of the oral valve of the zoœcium, and he shows that the leading stages exist in *Schizoporella ciliata*. Sometimes a moderately short avicularium of the ordinary type occurs; in other cases the mandible is more or less prolonged into a straight and slender spine. In specimens from the Queen Charlotte Islands the mandible has altogether lost its lid-like character and is now a very tall membrano-chitinous appendage, commonly exceeding in length the entire cell; from Ceylon or Bass's Straits still another form is known, in which the spinous process of the avicularium is furnished on each side with a delicate membranous expansion.

It is suggested that in the avicularian appendages is to be found a ready adaptability to change of circumstances, and Mr. Hincks considers that these observations bring out very forcibly the instability of the avicularian structure, so that he cannot agree with those who assign a high value to the appendicular organs for the purposes of classification.

Arthropoda.

α. Insecta.

Flight of Insects.*—R. von Lendenfeld, after some general considerations on locomotor organs, points out that insects with one pair of wings appear to be the most highly organized and possess the largest brain. Before the Jurassic period no two-winged insects seem to have existed; these later ones would appear to have been derived from the four-winged forms. The "dipterous" type seems to have been developed along two different lines; while in the Lepidoptera Rhopalocera the anterior wings are the larger, in the Orthoptera genuina the hinder are the larger; allied to the former are the Sphingidæ and the Hymenoptera with the anterior wings much the larger, and they culminate in the true Diptera in which the anterior wings are alone developed. On the other hand, the Orthopterous form leads through the Coleoptera, where the anterior wings form elytra, to the Strepsiptera, in which the anterior wings are aborted; lower than all these are the Neuroptera planipennia and the Libellulidæ in which both pairs of wings are equal in size. In discussing the question of the homology of the wings, the author states that his own observations incline him to the view of Fritz Müller that they are derived from lateral processes of the dorsal plates of the wings on which they are found, and that they are not modified tracheal gills.

The rest of the paper deals in detail with the characters presented by the Libellulidæ. A diaphragm of chitin separates the muscles for the wings from those for the legs; the exoskeleton is made up of a number of thin chitinous plates; there are various methods of articulation, some of which are exactly comparable to those that are found in the Vertebrata. Sixty-two separate skeletal parts are named and described. The wings are not only similar in structure but in action and function; the quantity of blood which makes its way into

* SB. Akad. Wiss. Wien, lxxxiii. (1881) pp. 289–376 (7 pls.).

them is very much less than it is, for example, in the Lepidoptera, and their wings are therefore exceedingly light.

The sixteen muscles and two ligaments are named and described, and an account is given of the method adopted for securing instantaneous photographs of the insects' wings. Two phases are to be distinguished in the movement of the wing, the movement from behind forwards, and from in front backwards; in both, however, there is an upwardly acting force; with this, there are associated other movements, resulting in the course of the wing being a more or less complicated curve, the directions of which depend of course on the extent to which these other forces act.

Nucleus of the Salivary Cells of the Larvæ of Chironomus.*—E. G. Balbiani reminds his readers that in 1876 he noted how the epithelial cells of the ovary of the Orthopterous insect, *Stenobothrus pratorum*, contained in their nuclei not ordinary nucleoli, but a large number of small subequal granulations, which he compared to a mass of bacteria. He showed that these united to form the filaments of the nuclear figures which characterize the different stages of the division of the nucleus (Karyokinesis), and that it followed that the nuclear filaments were not, at first at any rate, homogeneous, but formed of granules set along a single line. Confirmatory observations have lately (1881) been made by W. Pfitzner on the Salamander; but instead of using his complicated method of demonstration, the author has found that it is sufficient to treat fresh cells with acetic or chromic acid: when the action is prolonged the globules may be seen to fuse more or less completely with one another, and to give rise to filaments which are sometimes varicose, and sometimes completely homogeneous; it is under this condition that the nuclear filaments have generally been described and figured.

The salivary glands of *Chironomus* are two flattened organs, formed of a small number of large clear cells, with large nuclei, transparent, like the cells themselves; in the nuclei there are two large nucleoli formed by a granular refractive substance, and containing a more or less large number of vacuoles. In addition to these, there is a pale body of the form of a cylindrical cord, which is coiled upon itself in an intestiniform fashion. In larvæ of some age it is often broken up into filaments of varying length which may either remain free, or become attached to the envelope of the nucleus. Some little way from each extremity the cord is suddenly swollen out, and this may be described as a ring; when the cells are allowed to die in the blood of the animal, the ring, which was previously difficult to detect on account of its paleness, becomes finely granular, and so more evident. In living cells it is perfectly homogeneous, being neither granulated nor vacuolated. Entering into a detailed account of the cord, the author describes its transverse striæ and the disks of which it seems to be composed.

The influence of reagents reveals a difference in chemical composition; distilled water causes the cord to swell, till it becomes

* Zool. Anzeig., iv. (1881) pp. 637-41; 662-66.

almost invisible; the nucleoli resist the action for a longer time. Acetic or chromic acids (1 per cent.) or concentrated picric acid bring out the details of the nucleus, the disks of the cord, the rings at the extremities, and the nucleoli. After giving an account of the action of various colouring matters, the author says that he thinks no one will doubt that the cord is homologous with the intranuclear network of other nuclei; and that it is not, as most have supposed, really formed of homogeneous filaments, continuous with the nuclear membrane, and largely ramifying and anastomosing. The network has nearly always been described after the action of reagents on it; it is now seen how much these affect its original characters.

The nuclei of the cells of the larvæ of *Chironomus* may be looked upon as very complex elements, offering a true organization, if by that term we understand an assemblage of parts having fixed and constant relations to one another, and fulfilling special functions. As to the functions of this apparatus and its mode of activity, hypotheses are at present useless; not only animal, but also vegetable cells must be more closely studied, and the two carefully compared. In conclusion, notice is taken of the observations of Baranetzky on the pollen-cells of *Tradescantia*, where obscure transverse striæ were seen in the nuclear filaments, and a clear intranuclear substance, comparable to that found in *Chironomus*, was detected.

γ. Arachnida.

Structure of the Dermaleichidæ.*—After describing in detail the mouth-parts of these Arachnida, Dr. G. Haller directs attention to certain characters in the digestive tract which point to their close affinity with the Tyroglyphida and Dermacara; the tract being simple, and the saccular stomach divided into two parts, lying one behind the other, and not differing in function.

So again, in the structure of the male organs we find a not inconsiderable resemblance to the Tyroglyphida; the testes and their ducts are paired, the seminal vesicle and reproductive organ are unpaired, while the male is provided with organs of attachment, and with accessory organs developed on the extremities. Further investigation into details proves, however, that we have here to do with forms of a more lowly organization. Two, and in some cases three, different forms of females were observed. The first of them was impregnated by the male, but had no indications of any generative organs; the next had a matured ovum in its oviduct. The former of these is really an eight-legged larval form, and it is only in the next stage that the matured female is really present. The author justly directs attention to this remarkable peculiarity.

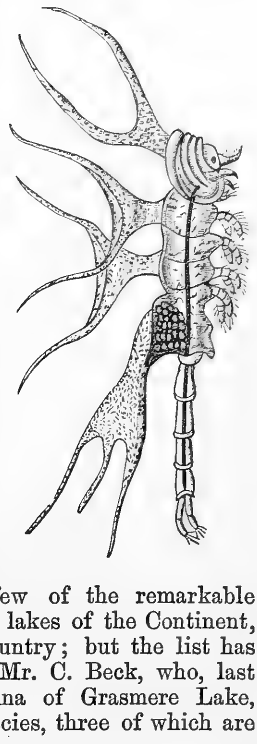
δ. Crustacea.

New and rare French Crustacea.†—M. Hesse here describes *Bimonaste bicolor* and *Scotophilus tricolor*, two parasitic Copepods

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 367–88 (2 pls.).
† Ann. Sci. Nat. (Zool.) xi. (1881) art. No. 8, 19 pp. (2 pls.).

which he found living in Ascidians. He also gives a further account of *Notopterophorus papilio* and *N. bombyx* (see Fig. 28), remarkable forms in which the body is provided with large delicate membraneous lamellæ, not unlike wings of Lepidoptera. The head has a kind of covering which is surmounted by two narrow expansions, longer in the female than in the male, and not found in the young. The wing-like expansions are attached to the dorsal portion of the thorax; they are evidently too delicate for any marked action, and it is probable that they are able to insinuate themselves between the tisues of their host; they can move with some rapidity, after the fashion of a butterfly's wings. When young, these curious creatures resemble a *Monoculus* in form. A systematic definition of the two species is appended, and reference for further details is made to the author's earlier papers (1864 and 1865.)

Fig. 28.



New British Cladocera from Grasmere Lake.*—Professor Ray Lankester points out that previous to his identification of *Leptodora hyalina* Lillj., and *Hyalodaphnia Kahlbergensis* Schödl, as British Cladocera in specimens from the Olton reservoir, few of the remarkable forms of Cladocera which occur in the larger lakes of the Continent, had been recognized as occurring in this country; but the list has now been extended by the observations of Mr. C. Beck, who, last summer, examined the Entomostracous fauna of Grasmere Lake, Westmoreland, and found the following species, three of which are new to British waters.

1. *Leptodora hyalina* Lilljeb. ♂. Taken Sept. 16th.
2. *Hyalodaphnia Kahlbergensis* Schödl. Abundant Sept. 9th to 16th.
3. *Holopedium gibberum* Zaddach. Thirty specimens, each encased in a gelatinous globe, Sept. 7th to 16th.
4. *Latona setifera* ♂ and ♀ Straus (Weissman). Sept. 3rd to 14th.
5. *Bythotrephes* sp. Sept. 14th. This appears to be a new species, distinct from the *Bythotrephes longimanus* of Leydig.

At the same time, Mr. Beck observed the following, already known to Baird as British species, but some being of rare occurrence: *Sida crystallina* O. F. Müller (Straus genus); *Daphnia vetula* Müller, *D. reticulata* Jurine; *Eurycercus lamellatus* O. F. Müller (Baird genus); *Alona quadrangularis* Müller (Baird genus); and *Peracantha truncata* Müller (Baird genus).

It appears probable that in lakes where species of the Salmonid

* Ann. and Mag. Nat. Hist., ix. (1882) p. 53.

Ceregonus are found, there also will be found the large deep-water Cladocera, such as *Holopedium* and *Bythotrephes*, which serve these fish as food.

The Entoniscida.*—Prof. R. Kossmann finds that only five previous papers by three investigators (F. Müller, Fraisse, and Giard) form the bibliography of this group. European forms are said to be hermaphrodite, while the Brazilian appear to be diœcious, but the author has found the males of the former, though their relatively smaller size is obviously a difficulty which may have caused the earlier incorrect statement. Two genera—*Entoniscus* and *Entione*—are recognized, and the differences between their males pointed out. In their case, as in that of the females, the peculiarities of the group, and their common characters with the Bopyridæ are insisted on; the differences between the females of the two genera of Entoniscida are duly noted, and the views of earlier naturalists critically examined. The author does not think it probable that there is any change of host, as Fraisse has supposed.

It is pointed out that two larval forms obtain with *E. cavolinii*; some of the differences which previous investigators have detected and looked upon as specific, he believes to be due to differences in age, and the tegumentary glands discovered by Fraisse have not been made out by Kossmann.

The Bopyridæ.†—In this third contribution to a knowledge of these forms, Prof. R. Kossmann deals with *Ione thoracica* and *Cepon portuni* n. sp. (found in *Portunus arcuatus*), of which he gives a careful account, with especial reference to the gills, and the differences between the male and female. So rare are these forms, that 10,000 Brachyura were in vain opened by Salvatore Lo Bianco, of the Naples Zoological Station, before it could be said that a Bopyrid was to be found in any European Crustacean. The parasitism of this creature is neither common nor rare, but only gives rise to local epidemics.

Vermes.

Anatomy and Histology of Scoloplos armiger.‡—W. Mau has selected this common form for a study of the Polychætous Annelids. The methods of examination have comprised the investigation of living forms, and of specimens hardened by being killed in picric or chromic acids, in which they were left for a fortnight; after washing, they were placed first in dilute and then in absolute alcohol; other specimens were killed in dilute, then placed for some time in stronger, and, finally, in absolute alcohol. The examples best adapted for sections were found to be those that had been treated with chromic acid. The most suitable colouring matters were saffranin, alum-cochineal, and picro-carmine. Sections were cut by the microtome or the razor after imbedding in paraffin.

* MT. Zool. Stat. Neapel, iii. (1881) pp. 149–69 (2 pls.).
† Ibid., pp. 170–83 (2 pls.).
‡ Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 389–432 (2 pls.).

After describing their habits and general form, the author gives a detailed account of their various organs. The cuticle is, as compared with that of the Oligochæta, excessively delicate (not more than 0·002 mm. thick); it is not provided with any tactile setæ or other processes, and when fresh, is with difficulty separated from the hypodermis; it is traversed by pore-canals, and there are, in addition to these, rounded lacunæ which are arranged in parallel rows. The hypodermis is best examined after treatment with chromic acid and alum-cochineal or saffranin; the latter colouring agent brings out the nuclei and the rod-shaped or spindle-shaped bodies; these are found in the intercellular substance, and there are in addition a number of pigment-granules. The muscular system is extraordinarily well developed, and consists of circular, longitudinal, and dorso-ventral muscles, as well as of obliquely-set muscles in the anterior region. As was to be expected, the cœlom or body-cavity is broken up by dissepiments into a number of chambers, which are most distinct in the posterior portion of the body. Into the formation of these dissepiments the dorso-ventral muscles enter; and the cavity only communicates with the outer world by means of the orifices of the segmental organs, the large pores which are found in the terricolous Oligochæta being here completely absent.

The most important point noticed in the enteric tract would appear to be the cæca, which are developed in its more posterior portion, and which have their walls specially modified; no definite opinion can be given as to their function, but they would appear to be secreting organs; they have some resemblance to the swim-bladder-like organs lately described by Eisig in the Syllidea,* but in this form they never contain gas, and their walls are not contractile. Passing to the nervous system, we find the author including the sub-œsophageal ganglia in the brain; the ventral cord is surrounded by muscles, and is not, as in most Ariciidæ (McIntosh), outside them. Transverse sections show the existence of a more or less rounded space, which leads to a belief in the presence of a canal extending through the ventral medulla.

The circulatory system has closed vessels with proper walls, and there would seem to be no lacunæ; the stomach is richly provided with blood-vessels, and there is a pair of transverse vessels in each segment, which are, for the greater part of the body, eminently contractile. The blood is more or less red.

At the time of sexual maturity, the hinder part of the body of the male is whitish, and that of the female brownish-yellow in colour; the ova or sperm fill up the space between the intestine and the sides of the segments, but the generative products of one segment are prevented by the completely developed septa from making their way into another segment. The ova arise in a cellular tissue which lies near those vessels which intervene between the walls of the intestine and those of the body; the ova do not break away till they are completely matured, and they then do not, as in some other Annelids, float freely

* See this Journal, *ante*, p. 44.

in the cœlom, but are confined to the segments in which they are developed. The spermatozoa are developed in great quantities, and are, when ripe, excessively active; they resemble in form those of *Magelona*.

As efferent ducts for the products, we have the so-called segmental organs; they differ somewhat from those of other Chætopods, being tubular structures, in which it is not possible to distinguish different regions; the whole is very short, and only just extends into the cœlom; the external and internal orifices are somewhat widened out, but are not specially differentiated. They are not developed in the anterior portion of the body, where their place appears to be taken by a coil of cells with distinct nuclei; these are regarded as glandular organs, but no efferent ducts can be detected, and their development must be studied before their homologies can be exactly defined. The body easily breaks, and regeneration was found by experiment to be somewhat complete, 22 segments appearing where 42 had been before, 20 where there had been 33, 26 for 40, 27 for 63, and 24 for 68.

Parasitic Eunicid.*—Dr. J. W. Spengel, in describing *Oligognathus Bonelliæ*, remarks that parasitic Polychæta would seem to be very rare, the young Alciopids which are parasitic in Ctenophora affording the only other real exception to the rule that the Polychæta lead a free life. On examining some *Bonelliæ* at Naples, the author found in their cœlom an orange-coloured cord which attracted his attention by its lively movements. Not more than 10 cm. long, with a thickness of 1 mm. in its middle, it had more than 200 segments, together with a region of incomplete segmentation. The maxillary apparatus was rudimentary, and there were only three small teeth on the upper jaw. In the observations which follow his systematic account, the author enters into some comparison of the characters presented by this new form with those which are to be seen in some of its allies.

In dealing with its nervous system, the author points out that, while the œsophageal commissure contains but few ganglion-cells, there is a well-marked sub-œsophageal ganglion in the second segment; in the next six or seven, there are, as in it, two ganglia; further back, the swellings are inconsiderable; the elements of the ventral cord are arranged in typical fashion, save that the fibres form not two but three connecting cords. When compared with its allies, it is shown to be remarkable by the possession of a secondary ganglion in each segment, by the great breadth of its anterior ganglia, and by the close connection between the ganglia and the epidermis. In it the ganglia are all subequal, but in *Halla* the anterior ganglia contain a few giant-cells, each of which is provided with a special thick investment, formed of concentric fibrous layers with numerous spindle-shaped nuclei. The tubular sheaths thus formed are comparable to the "fibres tubulaires gigantesques" long since described by Claparède. After discussing the arrangements found in other forms, the author concludes that it must still remain uncertain

* MT. Zool. Stat. Neapel, iii. (1881) pp. 15–52 (3 pls.).

whether the tubes filled with pale soft contents which traverse the central medulla of so many Annelids, are, or are not, all homologous structures; there can be no doubt that the tubular fibres of *Halla* and *Arabella* are the same as the neural canals or giant fibres of the Oligochæta; but much still remains to be made out as to their connections with the cells and their function. This, however, is certain that the Annelida, no less than the Arthropoda and the Vertebrata, present marked variations in the size of their ganglion cells. Passing to the peripheral nerves, the author demonstrates the circular character of this system, which has already been detected in *Sipunculus* and *Echiurus.* A sympathetic system was found in longitudinal sections of the body, when pale fibres were seen to be running parallel to the ventral medulla, and apparently connected with it by secondary ganglia.

The greater part of the enteric canal is very simple, the only complications being in the anterior region. A series of regular folds are found behind the mouth, and project considerably into the lumen of the tube; their substance is mainly composed of muscle, and, as compared with other Lumbriconereids, they are rudimentarily developed in *Oligognathus.* After describing in detail the structure of the jaws, the author refers to a canal which opens on the ventral surface of the anterior portion of the enteron, and which he thinks, though material has prevented from coming to a definite conclusion, may be homologous with the secondary gut of the Capitellidæ.

The segmental organs present nothing specially worthy of note here, and the reproductive organs were not matured in any specimen examined.

Development of Anguillula stercoralis.*—Professor E. Perroncito gives an account of his observations on the development of this endoparasitic Nematode outside the human body. After a medical history of a patient afflicted with this worm, and who, till he went to work in the St. Gothard Tunnel, was remarkably healthy, he states that he was able to convince himself that *A. stercoralis* may be developed in the intestine of man, without the necessity of any free-living larval stage. When the embryo leaves the egg it is 0·2 mm. long, and 0·01 mm. broad. The larvæ leave the body at different stages of development; and when cultivated at a temperature of from 22–25° C., do not all complete their development, or become sexually mature. In what may be known as the second stage, or that which is reached after sixteen or seventeen hours, they are longer and more delicate, are enclosed in a delicate capsule, and the stomach has lost its chitinous armature; they now have on the whole a very close resemblance to the larvæ of *A. intestinalis.* Those larvæ which attain the adult condition, retain the capsule till they attain maturity; they may become as much as ½ a mm. long. The sexes are separate, and the female is about a third longer and broader than the male, and contains about thirty eggs.

After discussing the zoological relations of this helminth,

* Journ. Anat. et Physiol. (Robin) xvii. (1881) pp. 499–519 (1 pl.).

Professor Perroncito elevates it into a new genus, to be called *Pseudo-rhabditis*, and he gives a technical definition. The larvæ are always killed at 48·5° C.; doliarine treated with hydrochloric acid occasionally, but not always, was a fatal poison, 1 per cent. solution of phenic acid was found to be constantly poisonous, as were other drugs, including an ethereal extract of male fern, especially when an alcoholic tincture of the same was added. The patient already mentioned was supplied by the author with an alcoholic liquor called *fermet*, and this was found to be mortal to the parasite.

Cercaria with Caudal Setæ.*—Mr. J. W. Fewkes describes a Cercaria, or larval Trematode, which differs considerably from anything he has been able to find in any published figures. The interesting feature is the Annelid character of the tail, a characteristic which he considers may indicate some new relationship between the Trematoda and the Annelida.

The Cercaria is marine, and always found at or near the surface of the water. Its length, when body and tail are extended, is about $\frac{1}{16}$ inch. The body walls are very transparent. Its motion through the water, as far as was observed, consists entirely of a "jerky" motion, brought about by the powerful strokes of its very muscular tail, a motion resembling very closely that of the nauplius of *Balanus*. With moderate magnifying powers, the motions of the tail are so rapid that they cannot be followed by the eye.

The head is very variable, its shape being sometimes contracted into a spherical ball, and at other times extended into an oval. At the extremity is the mouth. The stomach occupies a large part of the anterior central part of the body, and from it there is continued backward, a pair of blindly-ending vessels as in other Cercariæ. The most prominent structure of the body is a large medially placed sucker.

The tail is the most peculiar feature. Its general shape is hardly characteristic, and it owes its interest to the bundles of setæ arranged on opposite sides at intervals along the whole length. These setæ, of which there are many in each bundle, are straight, inflexible, and moved by muscles in the walls of the tail. Their resemblance to the setæ found in the segments of Annelids is very great.

New Type of Turbellaria.†—W. A. Silliman describes a singular worm which he found parasitic on a large green Nematoid, which was apparently parasitic on *Echinus sphæra*.

The body of the animal is sublanceolate, 2·25 mm. long, with an average breadth of 1·5 mm., and of a light brown colour. The suckers and hooks so characteristic of ectoparasitic Trematoda are wanting.

The epiderm is formed of tolerably regular hexagonal ciliated

* Amer. Journ. Sci., xxiii. (1882) pp. 134–5 (1 fig.).
† Comptes Rendus, xciii. (1881) pp. 1807–9.

cells, whose nuclei are very plainly visible. These cells are covered with a thin chitinous cuticle, perforated for the passage of vibratile cilia, by which the animal can move over the body of its host. The cilia of the ventral face are much longer and stronger than those of the dorsal. Beneath the epidermis is a basal membrane containing the brown pigment to which the colour of the animal is due.

No water-vascular system was observed, but its non-existence cannot be positively asserted.

The genital organs are the most remarkable characteristics of the animal. The male organs include numerous testicles and a penis enclosed in a sheath; the female organs a double ovary and *pseudo*-vitellogen, a uterus, and vagina. The testicles are placed in the anterior third of the body, and are in the form of small sacs, each with a very fine duct, which unite behind the intestine and debouch in the penis. The latter is a long canal of uniform diameter, which in a state of repose has numerous flexions. Its walls are muscular, and covered with a thin chitinous layer. It terminates in a sort of cirrus, ·018 mm. in diameter.

The uterus, like the sheath of the penis, is median, and situated below the latter; it terminates towards the middle of the body in a cul-de-sac, and more often than not contains an egg enclosed in an ovoid shell, which has an extremely long and fine peduncle. The shell and its peduncle would be secreted by the cells which line the wall of the uterus.

The pseudo-vitellogen occupies the second third of the body, and has the form of numerous ramified tubes, those on each side uniting towards the median line and debouching in the uterus. Immediately behind these openings are the ovarian cells; these are more or less in the form of a hand, of which the wrist communicates with the uterus, whilst the fingers are directed backwards and spread out. The eggs develope in the extremities of these fingers, and become larger in proportion as they advance towards the uterus. Their nuclei and nucleoli are very visible.

The vagina, which is never found in the Turbellaria, but is well marked in the Trematoda, opens on the dorsal surface in the posterior quarter of the body, and thence runs forwards towards the uterus. At the plane of the opening of the ovaries it dilates into a receptaculum seminis with muscular walls, which communicates with the uterus by a narrow and short canal.

This aberrant creature thus presents affinities (by the ciliated epiderm, digestive apparatus, male organs, and two ovaries) with the Turbellaria on the one hand, and (by the vagina and disposition of the pseudo-vitellogen) with the Trematoda on the other. Seeing that the young Trematoda are ciliated, but later on lose their cilia, the Trematoda may be considered as modified if not degraded Turbellarians. The animal in question being, therefore, a transition form, should represent a new suborder of Turbellaria.

The author proposes to designate it *Syndesmis*, in order to express its morphological *rôle*, and promises further details on the subject.

Systematic Position of Balanoglossus.*—Professor A. Giard has some observations on the paper of Metschnikoff † on this form, in which he points out that the presence in its larva, *Tornaria*, of a very special heart (which he has never observed in the larvæ of any Echinoderm), the relatively late appearance of the ciliated circlets, and the existence of a muscular band uniting the aquiferous system to the median point of the eye-spots, all present difficulties which prevent us from at once accepting the view of the close relationship of the Enteropneusti and the Echinodermata.

Attention is directed to one point of similarity; four years ago the author showed that, in the Echinoidea, after the reproductive period has passed, the genital glands form culs-de-sac filled with very large elements which have no resemblance to generative cells, and have within them a large vacuole, which owes its appearance to the atrophy of the nucleus; in addition, there are in the cell small brownish concretions, similar to those found in the renal organs of numerous Invertebrates; deutoplasmic elements which are, later on, absorbed by the developing genital cells, and a large number of crystals of phosphate of calcium are also present. From these observations the author concluded that, for a certain part of the year, the genital glands of Echinoids took on an excretory and a deutoplasmigenous function. A renewed study of Kowalevsky's memoir on *Balanoglossus*, showed the author that a very similar state of things was to be observed in that animal, but he here insists that it would be rash to give too much value to a morphological similarity which may be simply due to a similarity of function. A fair objection would be raised by any one who should point out that nothing of the kind is to be observed in the Starfishes. At the same time, the absence of segmental organs in *Balanoglossus* would seem to be very significant. If we distinguish the excretory apparatus of the Invertebrata as (α) protonephridia, e. g. the organs of Turbellaria, Cestodes, Trematodes, Rotifers, &c., and (β) the deutonephridia, or segmental organs properly so called, we find that we cannot place with the former either the water system of Echinoderms, or that of *Balanoglossus;* nor are they homologous with the modified deutonephridia.

The relationship of *Balanoglossus* to the Tunicata is absolutely denied, the resemblances between them being regarded as purely analogous; provisionally, therefore, Giard accepts the general doctrine of Metschnikoff, without pretending to exactly define the genealogical position of this curious and interesting form.

Nervous System of Platyhelminthes.‡—Of the fourth and fifth parts of Dr. A. Lang's contributions, the most important point is the discussion of the character of the nervous system as treated comparatively. Comparing them with the Ctenophora, the only group of the Cœlenterata which have a corresponding histological and anatomical differentiation of the germinal layers, the author points out that in

* Bull. Sci. Dép. Nord, iv. (1881) pp. 372–8.
† See this Journal, i. (1881) p. 462.
‡ MT. Zool. Stat. Neapel, iii. (1881) pp. 53–96 (2 pls.).

both the mesenchyma gives rise to muscular, nervous, and connective tissue. The nervous system of the Ctenophora consists of a nervous plexus scattered through the mesenchyma, of an ectodermal plexus with eight fibrous tracts, and of an ectodermal sensory body. In that of the Polyclades we distinguish a nervous plexus closely connected with the mesenchymatous musculature, which in all probability arose in connection with the musculature from the cells of that layer; a system of nerve-trunks, placed in the mesenchyma, connected by commissures and anastomoses, and radiating from a single point; of these eight are specially noticeable. The third portion consists of sensory organs (eyes), with sensory nerves, the prime origin of which appears to have been from the ectoderm. The three parts are here in connection with one another, and this, in addition to such differences as are due to adaptation, appear to be the only important points of distinction between the two groups.

Starting from the Polyclades, we may note that differentiation has proceeded in two directions—the one associated with the degeneration of the parasitic, the other with the elevation of the free-living forms. The brain is the point at which all the nerve-trunks meet; it is, therefore, largest in those forms in which the nerve-trunks are the best developed; and its size, in the Polyclades, though they are the most primitive of the Platyhelminthes, should not be any cause for astonishment. Among the Trematoda, *Tristomum* most nearly approaches them in habit and organization; the brain, however, is more simple. This simplicity is still more marked in *Pleurocotyle* and *Distomum nigroflavum*, where the brain is merely a transverse commissure. In *Amphilina* and those Cestoda in which the scolex is but feebly provided with muscles, the brain is so feebly developed as to be barely distinguishable; where, however, as in the Tetrarhynchi, the musculature is more abundant, the transverse commissures are correspondingly better developed.

In the Triclades the brain is feeble in the fresh-water forms; in the terrestrial ones it is impossible to speak of it as a definite central organ. In the marine forms, e.g. *Gunda*, it is highly developed, and consists of a large posterior, motor, transverse commissure, and a large anterior sensory commissure, the two being connected together by a sensori-motor commissure. After dealing with its position, the author passes to the *Peripheral portion*. The concentric arrangement of this in the Polyclades has been already referred to. As before, *Tristomum* presents the closest resemblance to that group, but certain changes have been effected, in consequence of the development of the ventral sucker, and there has been a reduction of the nerves at the anterior end of the body. In *Pleurocotyle* and *Distomum* little but the two longitudinal nerves have been preserved, and the commissural system would seem to have completely disappeared. In *Amphilina* the longitudinal trunks pass into one another; in the Tæniadæ the branches for the suckers are still retained; and the Tetrarhynchi have special paired nerves, which pass to the proboscis; no commissural fibres have as yet been detected in the Cestoda.

Along the other line of development the central nervous system takes on an arrangement which strikingly calls to mind those found in the higher segmented forms; in consequence of the reduction of the lateral portions of the body and the simplification of the digestive and generative systems, the anterior and lateral nerve-trunks, as compared with the longitudinal trunks, have become quite inconspicuous; and in many cases the same fate is reserved for the brain.

The fresh-water Triclades come nearest to the Polyclades, but the longitudinal trunks unite posteriorly. The land forms, as represented by *Rhynchodesmus*, present us with an arrangement in which the brain is nothing more than a somewhat well-developed portion of the longitudinal trunks with transverse commissures somewhat thicker than in the other parts of the body. The regular arrangement of the peripheral portion is best seen in the marine Triclades, *Gunda* having longitudinal trunks which, at perfectly regular distances, are connected by simple unbranched commissures, and, so far as segments can be made out at all, there is a transverse commissure for each segment. The homology of this system is fully discussed.

The mesenchymatous nervous system consists, in the Polyclades, of a fine network of nervous substance which is closely applied to the ventral and dorsal muscular layers; the meshes are generally polygonal, and the system is best developed in the region of the sucker. In the terrestrial Triclades the meshes are generally quadrangular; in the Trematoda the system is best developed in connection with the large ventral sucker, and ganglion-cells of considerable size may here and there be detected in it. Among the Cestoda *Pleurocotyle* has the plexus largely developed near the proboscis.

No sensory organs, other than eyes, have been detected in the Platyhelminthes; a large number of these are always to be found in the Polyclades, in the Trematoda they are less numerous, and in the Cestoda they are either absent or are confined to the free-living stages. In most of the fresh-water and terrestrial Triclades two are alone found. In all cases there is presented a marked similarity of structure; optic cells, formed from the ends of the optic nerve, pigment-cups, and a crystalline body can always be made out.

No complete series of observations have been made by the author on either the Rhabdocœla or the Nemertinea.

The nervous system of the Triclades, the more general characters of which have already been pointed out, is dealt with in detail; in treating of the fresh-water forms the author has especially studied *Planaria torva*, and he finds himself in essential agreement with Graff, Kennel, and the Hertwigs.

In dealing with the land forms he has the advantage of Moseley's investigations into the land Planarians of Ceylon; a study which, he says, he has daily learnt to value more and more, though that author has called the nervous the primitive vascular system. This he regards as an error of interpretation which has been corrected by others, though the details have not been essentially altered.

Gunda has been the chief example of the marine forms, and the author has been able to distinguish in it a motor portion which is formed by two ventral enlargements, from which there arise the anterior and posterior longitudinal nerves, and which are connected by motor transverse commissures. The sensory swellings are more dorsal and anterior in position; they give off the sensory nerves, and are likewise connected by commissures. Between these two sets there is a sensori-motor commissure. Histological structure no less than anatomical arrangement reveals the higher grade of development seen in the marine as compared with the other forms; the sensory are distinguished from the motor nerves by being invested in a continuous layer of ganglionic cells.

Structure of Gunda segmentata, and the Relationships of the Platyhelminthes with the Cœlenterata and Hirudinea.*— Dr. Arnold Lang commences by revising the classification of the lower Platyhelminthes: he would drop the term Turbellaria, and adopt in its place three orders, each of them the equivalent of the Trematoda, Cestoda, or Nemertinea; the dendrocœlous Turbellaria are either monogonoporous, or digonoporous, and for them he proposes the terms of Polyclades and Triclades, while the third order would be called the Rhabdocœla.

Gunda segmentata is a delicate marine Planarian about 6 mm. long, and very active; after giving a technical description of the species, the author passes to its epithelial layer, some of the cells of which are filled with the small characteristic rods, while others, on the ventral side, form a zone, which is broadest at the anterior end of the body; these attaching cells project considerably beyond the rest, and their free surface is roughened. The enteric system receives the name of the cœlenteric apparatus, inasmuch as the author is convinced that it is the homologue of the cœlenteric apparatus of the Cœlenterata, and of the enteron and cœlom of the Enterocœla. In all essential points it agrees with that of the other Triclades; the mouth leads into the so-called proboscis cavity, from the walls of which are developed muscular folds which project into the cavity, and form the proboscis, in the fashion of a diaphragm. The cavity communicates by an orifice with another cavity, which is not, as is the former, lined by ectoderm, but by endoderm; from this there are given off the branches of the intestine, the anterior of which lies in the middle line, and ends blindly at the anterior end of the body. The two lateral primary branches lie close to the sides of the proboscis-sheath, and end blindly at the hinder end of the body; from these three primary branches are given off secondary diverticula, the cœlomic diverticula of the enteron; these agree in all essential points with the paired cavities of the enterocœle of higher forms; they are generally unbranched, or are forked at their peripheral ends. There is no special musculature for the walls of the intestine; in the enteric cells we may sometimes see large vacuoles during life; these are called the excretory vacuoles. If we compare the above account with the arrangements which obtain in the *Ctenophora*, we find there that the so-called stomach is lined with ectoderm, and is provided with glandular ridges, that the succeeding cavity is lined by endoderm,

* MT. Zool. Stat. Neapel, iii. (1881) pp. 187–252 (3 pls.).

and that from the funnel there arise the gastro-vascular canals, in the form of paired ones which pass off laterally and branch, and an unpaired one which passes to the aboral pole, and there opens; on the other hand, the unpaired branch in *Gunda* only opens to the exterior in an early stage.

The Polyclades, like the Ctenophora, are hermaphrodite; and in both groups the generative products arise in close relation to the branches of the enteron; Chun has described them as having, in the Ctenophora, their origin in the ctenophoral vessels, that is to say, from the endoderm; in the Triclades they are developed from the enteric epithelium, so that the homology would appear to be complete.

The excretory organs of the Ctenophora are regarded as being represented by those pores by means of which the branches of the vessel of the funnel are brought into relation with the outer world; in *Gunda* it consists of large canals, which anastomose with one another, and of a number of fine excretory capillaries which are considerably branched, but which do not anastomose. The large canals here and there give off large branches to the dorsal surface of the body without opening into contractile vesicles. Throughout the whole body of the animal there are scattered a number of smaller or larger vacuoles, which have a considerable resemblance to the contractile vesicles of the Infusoria. These vacuoles are not arranged irregularly, but are united into small groups, and when one of them is examined, we see that it is supplied by a branch from the excretory capillaries, and there is a ciliated band between the vacuoles. A fact, to which the author attaches much importance, is the presence of a large number of ciliated infundibula in and on the epithelium of the branches of the enteron. The vacuoles which surround the funnel cannot be distinguished from those which are found in the enteric cells; the protoplasm of the ciliated funnel is the plasma of an enteric cell, and the funnel is a hollowed endodermic cell, ciliated within. The homology between these structures and the protoplasmic networks to which they give rise, with the intercellular lymphatic plexus of Fraipont and Francotte, and the subcutaneous nerve-plexus found by Ihering in *Graffilla muricola* is insisted on, and it is found that, taking all the characters into consideration, they must be regarded as being formed on the same type as those of the Cœlenterata.

The musculature of the Polyclades arises from the four primitive cells of the mesenchyma; the cells which are to become muscular fibres are arranged in layers under the epithelium, and their arrangement, like the mode of locomotion, is different to that which is seen in the Cœlenterata, but it is to be explained as due to their creeping mode of life, which demands a more regular distribution of the fibres, and a greater development of the superficial muscles.

Our space will not allow us to follow the author into the comparisons which he institutes between *Gunda* and the fresh-water Triclades, or the Hirudinea; he finds, however, that the Leeches are closely allied to *Gunda;* and dealing with *Trochosphæra,* he points out that all larvæ of its type are only provided with organs which are, physiologically, most necessary to it; by means of these partly provisional organs, the larva seeks its food, and the material for afterwards developing its body; in other words, the trochosphere does not represent the whole body of a Platyhelminth, but merely the cephalic portion of *Gunda*, with a fresh structure, the anal segment.

Echinodermata.

Nervous System of the Ophiuroidea.*—N. Apostolides, who has already† examined and described the circulatory and respiratory organs of this little-studied group, says that the circum-oral nerve-ring is contained in a "perineural" space which forms part of the body-cavity, and communicates with the general body-cavity at the point of entrance of the radial nerves into the arm; the space is triangular in transverse section, and is bounded on the outer side by the second discoid ossicle of the skeleton, and above and below by two membranes which originate in the point of union of the stomach and œsophagus, and are inserted on the ossicle. The nerve-ring itself forms a vertically flattened band. The radial nerves pass off from it horizontally, each traversing the foramen in the second discoid ossicle; each then turns upwards as far as the ventral plate, when it again becomes horizontal and then traverses the furrow of the arm. The annular canal of the water-vascular system and its branches lie outside the corresponding parts of the nervous system. Histologically, the nerve-band consists of two distinct tissues, the one ventral, consisting of brown cells with large nuclei and not coloured by picrocarmine; they have been wrongly regarded by most writers as constituting the essentially nervous element, but they resemble rather the pigment-cells of Vertebrata. The dorsal portion of the band is the true nervous part; it forms a very small portion of the whole band, and lies in a groove on its superior aspect; it consists of extremely delicate fibrils, between which pale bipolar cells lie scattered, not aggregated into ganglia.

The radial nerves exhibit certain dilatations opposite to intervals between the ossicles, but they are composed of the same non-nervous matter as that of which the ventral part of the ring consists. No branches are given off by the central ring, but the radial nerves give off from their origin a pair of nerves, the upper one of which goes towards the first tentacle and, when near it, divides; the two twigs thus formed course round the end of the tentacle and meet on the opposite side of it. The exact distribution of the nerve in the walls of the tentacle is unknown. The lower of the branches of the radii goes towards the muscles which lie between the angles of the mouth. Two similar pairs of nerves are given off by the radial nerve before it reaches the arm and another pair within the arm, all having the same distribution as the first pair.

American Comatulæ.‡—In his preliminary report on these forms Mr. P. H. Carpenter states that he thinks he has discovered as many

* Comptes Rendus, xcii. (1881) pp. 1424–6.
† See this Journal, i. (1881) p. 466.
‡ Bull. Mus. Comp. Zool. Camb., ix., No. 4 (1881) 20 pp. (1 pl.).

as forty new species in the collections dredged in the Gulf of Mexico and the Caribbean Sea. Nearly all were obtained from depths less than 200 fathoms; new and very singular types were obtained on the three occasions when Comatulæ were brought up from more than 300 fathoms. As very similar conclusions are to be drawn from the 'Challenger' collection, it seems that Comatulæ are essentially inhabitants of shallow water. When we compare the two collections it is interesting to see how they supplement one another. Ten-armed forms abound in the Caribbean, while in the eastern seas the majority have the rays always dividing, in some cases as many as seven times. The characters of several little-known species are discussed, and *Antedon spinifera* n. sp., and *Actinometra pulchella* Pourtalès are described in detail. Attention is again directed by the author to the characters which distinguish the genera *Antedon* and *Actinometra*, and these are usefully summarized in a table.

Two Pentacrinoid forms were found entangled in the arm of *Act. meridionalis*, and are presumably the young of that species; if so, they are probably the first Pentacrinoid Actinometræ that have been observed: a study of these specimens and of young Antedons leads to the belief that the late appearance, as a whole, of the basal pinnules is a "marked developmental character among the Comatulæ." This is of interest in connection with Mr. Carpenter's account of a new genus *Atelecrinus*, in which the basal circlet is complete in the adult as it is in some Pentacrini, and the earlier stages of Pentacrinoid larvæ. In the characters of its calyx this new genus retains permanently larval characters; so, too, there is an absence of pinnules from the lower part of the arm. *Ant. cubensis* with the new species *A. balanoides* will belong to this genus.

Cœlenterata.

Characters of Stinging-cells of Cœlenterata.*—Dr. C. Chun recalls the fact that late investigations have directed attention to the nature of the processes which connect the stinging-cell with the supporting lamella ("mesoderm"); Claus has regarded them as muscular fibres, and the brothers Hertwig as nervous structures. If we examine their mode of termination we find that they may or may not pass into the ectodermal longitudinal muscles of the tentacles. Observations tending to the conclusion that the processes in question are representatives of muscles are confirmed by the examination of *Physalia*, for in this Siphonophore it is to be observed that hundreds of muscular lamellæ arise, with extraordinary regularity, from the muscular band which passes to some of the filaments; the vessel running through the middle of the band gives off, under each battery of stinging-cells, a widening branch, the endodermal cells of which are remarkably increased in size beneath the battery. In other words, we find in *Physalia* a mesoderm well developed and traversed by cellular elements. The rounded nettle-capsules of each battery may be small or superficial, or larger and deeper. The stalks of the

* Zool. Anzeig., iv. (1881) pp. 646–50.

small stinging-cells are distinctly transversely striated; in the case of the larger cells we find that the stalk contains in its centre large oval nuclei, the contractile substance is broken up into 8–12 transversely striated fibrils placed at regular distances from one another; at the level of the capsule these branch dichotomously, and at the end where the cnidocil is placed we find a large number of fine contractile fibres converging in a regular manner, and at regular distances.

Now that the connection of muscles with the stinging-cells has been made certain, it is easy to see what is the real nature of the pressure on the wall of the capsule, which has been universally recognized as necessary for the protrusion of the spiral filament. When the network of fibrils contracts there must be a certain pressure on the wall; where this network is absent, the contraction of the stalk must press the capsule against the tissues which underlie it; and both causes may act, as in *Physalia*, at the same time. As to the irritability of the muscles it is to be noted that the necessary connection of the muscular stalk with nervous elements has so far been worked out by Chun in *Physalia* that ganglionic cells have been there observed, and that sensory hairs are always richly developed in the region of the urticating batteries.

Morphologically, the stinging-cells appear to represent not glands, the secretion of which forms the capsule, but epithelio-muscular cells.

Development of the Cœlenterata.*—In these comparative embryological studies E. Metschnikoff considers the formation of the endoderm in the Geryonida, and the development of the *Cunina* parasitic in *Carmarina*.

In dealing with the former, the author refers to the doubts expressed by Professor Haeckel as to the reality of the delamination method of the formation of the gastrula; and relates how in *Carmarina fungiformis* he was able, at the stage of the formation of thirty-two blastomeres, to separate the finely granular ectoplasm from the wide-meshed endoplasm; most of the cells were seen to be dividing, and this process of division was best marked in the nuclear spindle. Those that divided radially gave rise to new blastodermal elements, while others which divided tangentially separated the endoderm from the ectoderm. In a second form, *Liriope eurybia*, the delamination-process was most clearly observed, some of the blastodermal cells grew deep into the cleavage cavity, the nuclei were seen to be dividing; when the cell protoplasm was constricted the ectoplasm was almost exclusively found in the peripheral and the endoplasm in the central segment. This process was succeeded by the formation of a separate endodermal layer and then of a diblastula.

Dealing with the *Cunina* parasitic on *Carmarina* the author examines the accounts of the formation of the gastrula in the *Hydromedusæ;* and in giving a description of his own observations states that the youngest form examined by him formed a small white dot on the margin of the umbrella of *Carmarina fungiformis;* under the

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 433–44 (1 pl.).

Microscope it was seen to be a rhizopod-like organism with a rounded cap; that is to say, the larva proper contained a colossal amœboid cell and a bell-shaped covering of flagellated epithelium. The large cell gave off a number of homogeneous processes, many of which branched or were flattened out at their free ends. Within there was a large nucleus, closely resembling the central capsule of many Radiolaria, and this was invested in an elastic membrane, and had finely granular contents. This large cell is the body which was spoken of by Uljanin as the finely granular mass within the gastric cavity. The further stages of development are characterized by the overgrowth of the colossal amœboid cells by the flagellated cells, and the consequent formation of the oviform larva, which Uljanin regards as the starting-point of his invaginate archigastrula; but the author points out that there is in it no round blastopore, but only a fine slit; this does not serve for the ingestion of nutriment but only as a means of passage for the pseudopodia of the enclosed colossal cell. The larvæ, increasing in size, become elongated, and often triangular in form; the ectoderm is sharply separated from the endoderm, and consists of a single layer of delicate flagellated cells; while the endoderm forms a single layer of cylindrical-flattened cells.

Gemmation commences even at this stage, a longitudinal section revealing a diminution of the two germinal layers at the point where the mouth of the first Medusa appears later on; a well-marked projection at the oral pole forms the proboscis of the first Medusa-bud. In later stages we find that the colossal cell is long persistent; the first sign of degeneration would appear to be the appearance of several—perhaps renal—concretions; later on this degeneration becomes gradually complete.

The author is of opinion that the whole life-history of this parasitic Medusa presents a series of secondary adaptations, which are in causal connection with the parasitic habit; the alternation of generations is of a secondary nature, and the asexual generation is characterized by the loss of the genital organs and of a number of the other organs of a Medusa.

Nervous System of Hydroid Polyps.*—C. F. Jickeli states that he has discovered nervous elements in these, the only Cœlenterata in which they have not yet been observed. In the arms of the hydranths of *Eudendrium*, he found between the flat ectodermal cells and the longitudinal muscular fibres, branched cells, whence processes pass off to a number of urticating cells, or become lost between the muscular fibres; there is also a direct connection between the ganglionic cells. He asserts the existence of a nervous plexus which is continued forwards to the hypostome, and which extends also into the hydrophyton. Near the circlet of glandular cells at the base of the hydranths there is a larger collection of ganglia; but the connection by nerve-fibres between the two was not made out. The nervous system would appear to be confined to the ectoderm.

* Zool. Anzeig., v. (1881) pp. 43–4.

Remarkable Organ in Eudendrium ramosum.*—When engaged in his investigations into the mode of origin of the generative products of this hydroid, Dr. A. Weismann observed remarkable outgrowths on the head of the hydranth, of which, at first, he took no especial notice, as he regarded them as pathological products. They are horn-shaped stout processes growing out laterally from the head of the polyp; in form, though not in dimensions, they resemble a tentacle, with the exception that they are not thinner, but, as a rule, swollen at their free ends; they are formed by the two body-layers, and contain a continuation of the body-cavity; they are not found on all the hydranths of a colony, and this might lead us to think that they are degenerated structures; that, however, they are not degenerated gonophores is shown by the fact that, while all gonophores arise below the circlet of tentacles, or in the upper half of the hydranth, these are always developed below the hydranth; again, their structure shows that they have a definite function, they are actively motile, have a well-developed muscular layer, and are so remarkably well provided with urticating organs that they might be spoken of as cnidophores.

If we enter into the details of their structure, we find that the ectoderm only differs from that of the hydranth in its much richer supply of urticating organs; while there is nothing remarkable in the supporting lamella, there are, in addition to the epithelial cells of the endoderm, subepithelial cells lying on the supporting membrane and giving origin to circularly arranged muscular fibres: as yet circular muscles have only been observed in *Tubularia* among the Hydroid Polyps. In *Eudendrium* the circular muscular layer of the cnidophores is strongly developed and consists of very fine long fibres, which frequently exhibit a delicate transverse striation. After this description it can hardly be doubted that we have to deal with an offensive organ; the power of active movement, and the notable supply of stinging organs of colossal size sufficiently demonstrate the correctness of this view of their function.

The cnidophores always arise from a circular but indistinct wall of ectoderm, which is separated off by a circular groove from the wall of the stalk; this groove may be known as the glandular ring, and the wall as the urticating wall. In the region of the former the ectoderm cells are in one layer only, or, the glandular cells reach to the surface.

Viewed morphologically, the cnidophores are seen to be processes of the body-wall; in their earliest stages they are blunt, broad, solid processes of the urticating wall developed by a thickening of the ectoderm. In the next stage they contain an endodermal process, and thence to the complete condition there is every kind of intermediate stage. It is important to note that they only arise on developed hydranths, for this shows that they are, phylogenetically, relatively young organs. Their presence on some hydranths only presents some difficulties, and we can only suppose, till they shall have been studied during life, that they are developed as a protection against

* MT. Zool. Stat. Neapel, iii. (1881) pp. 1–14 (1 pl.)

some special kind of enemy. If it be true that they are not found on other species of the genus, we shall have another proof of their late development in time; their great size has prevented their development in large numbers on the same person, and may be the explanation of their asymmetrical character. No organ known in any other Cœlenterate can be compared with them, with the exception of the nematophores of the Plumularida, in which there is a process continued from the endoderm, though one that is only feebly developed. Three kinds of offensive organs seem, therefore, to have arisen independently of one another, for in the Hydractinidæ they are represented by the so-called spiral zooids.

Siphonophora of the Bay of Naples.*—M. Bedot finds that the Bay of Naples is one of the richest of all parts of the Mediterranean for these interesting forms; in one season he found 17 species, and altogether he knows of 19; all the families of the order are represented, and *Physophora philippii*, *Forskalia contorta*, *Halistemma rubrum*, *Praya diphyes*, and *Diphyes quadrivalvis* are very abundant. Of the last-named form the author had some specimens 60 cm. long, and he once observed an abnormal example, with three swimming-bells.

Ctenophora of the Bay of Naples.†—A very complete abstract of this monograph by the author, Dr. C. Chun, will be found at pp. 193–5, and 212–26 of Part 1 of the 'Zoologischer Jahresbericht' for 1880.

Protozoa.

Symbiosis of Lower Animals with Plants.—Yellow Cells of Radiolarians and Cœlenterates.—See *infra*, BOTANY, Algæ.

New sub-class of Infusoria—(Pulsatoria).‡—Three years ago Mr. P. Geddes described § some curious cells which occur in large numbers in the mesoderm of the Planarian *Convoluta schulzii*. The cells are a little smaller than the red blood-corpuscles of the Frog, are nearly in the form of a slightly curved pear, and have a large central vacuole, filled with fluid. On the wall of this cavity, and towards the more convex side of the cell, almost parallel with its principal axis, there is a row of homogeneous and transparent fibrillæ which are inserted at their upper and lower extremities in the ordinary protoplasm of which the other parts of the cell is composed. This differentiation into a granular and fibrillar part is comparable to that which takes place in the embryonal muscular cells of the Tadpole, and recalls somewhat the structure described by Lankester in the heart of Appendicularia. If these cells are examined free in sea-water it is seen that they are in a state of rhythmical contraction, the rapidity and vigour of which are equally surprising, the most active pulsating from 100 to 180 times per minute; each

* MT. Zool. Stat. Neapel, iii. (1881) pp. 121–3.

† Fauna u. Flora des Golfes von Neapel, Mon. I. pp. xviii. and 313 (22 figs. and 18 pls.).

‡ Comptes Rendus, xciii. (1881) pp. 1085–7.

§ Proc. Roy. Soc., xxviii. (1879) p. 449.

time the principal axis becomes more strongly curved, and the cell shorter and broader. This change of form depends exclusively on the contraction of the inner fibres, the other parts of the cell remaining quite passive. The movements of the cells soon begin to slacken, become irregular and feeble, finally cease, and the cell bursts. Its protoplasm soon perishes, but the fibres resist for a longer time the action of the water, and even exhibit a trace of contractility like dying cilia.

Numerous observations have convinced Mr. Geddes that these cells are in reality parasites. Other species of Planarians possess nothing like them. The delicacy of their protoplasm distinguishes them from the true tissue of the *Convoluta.* Moreover, they do not form tissue, and have no definite disposition. Regarded as parasites, their structure, apparently so abnormal, is readily derived from the type of ordinary Infusoria by the suppression of the cilia (which would not be available for locomotion among the cells of the mesoderm) and the differentiation of the contractile vesicle.

This differentiation is certainly very remarkable from every point of view when we consider the relatively enormous size of the vacuole, the development of the contractile fibres which limit it, or the rapidity of their contraction.

The author proposes to call this Infusorian *Pulsatella convolutœ*, and as it is so distinct from either Suctoria, Ciliata, or Flagellata, to create for it a fourth sub-class Pulsatoria.

Skeleton of the Radiolaria.*—Professor Bütschli deals especially with the *Cyrtida*, having had the advantage of studying a number of fossil specimens from Barbadoes. He commences with a study of *Cœlothamnus* (?) *davidoffii* n. sp., a Phœodarian in which the skeleton is as much as 1½ cm. in diameter. Examined with the naked eye, it is seen to be a (marine) organism, stellate in form, with sixteen relatively long rays, which appear to arise from a common centre. These rays are skeletal parts, and are, with the centre, imbedded in a common gelatinous mass. Belonging to Haeckel's family Cœlodendrida, its exact generic position must still remain a matter for discussion. The central portion is formed of two separate valves, which resemble one another in their structure, though not in their form. The details of their characters and of their connection with the rays is given.

The structure and relations of the Acanthodesmida, Zygocyrtida, and Cyrtida (Cricoidea: Bütschli) are then dealt with in detail; and the author concludes by pointing out that he cannot regard as natural Haeckel's division of the Cyrtida into Mono-, Di-, and Sticho-cyrtida. He can only distinguish two separate phyla, but he is careful to point out that our knowledge of these forms is at present very slight.

Recent Researches on the Heliozoa.—L. Maggi † has observed on a *Spirogyra* a form belonging to Cienkowski's genus *Nuclearia*, and,

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 485–540 (3 pls.).

† Rendic. R. Istit. Lomb., xiii. (1880) fasc. 20. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 154–5.

considering it, on account of its having two nuclei, to be a new species, assigns to it the name *N. duplex.* This species undergoes encystation occasionally, like the other *Nuclearia*, and during the process Maggi saw the two nuclei increase by fission to four. Then followed the division of the envelope of the cyst, in such a way that one of the portions into which it divided enclosed the old nuclei, and the other the newly-formed nuclei. This bi-nucleate *Nuclearia* the author believes himself justified in regarding as exhibiting a most important phylogenetic step towards the bi-nucleate condition shown by the fertilized ovum in the simultaneous occurrence of a male and a female nucleus, and finds the explanation of this doubly-nucleate developmental stage of the Metazoan ovum to lie in the existence of a phylogenetic bi-nucleate Protozoan predecessor of the character here described.

G. Cattaneo,* after a short historical survey of the investigations which have been made among the Heliozoa, describes his observations on *Acanthocystis flava* Greef, made on a single specimen in the course of two mornings. As might have been expected, he has but few facts to show, although the conclusions which he strives to draw from them are none the less far-reaching. He cannot regard the external, vitreous, colourless protoplasmic zone of *A. flava*, which has been described as ectosarc by various authors, as such, but considers it to be what he terms *mesoplasm.* The reasons for this opinion are that it contains the contractile vacuole, and sends out the fine pseudopodia which serve only as organs of prehension, these being the characters of the mesoplasm, as elaborated by Maggi in the case of *Podostoma*, &c. The ectoplasm proper of the present form, *Acanthocystis*, is said to be developed into the silicious skeleton, which cannot be regarded as a product of excretion of what is usually called mesoplasm. The author finds a confirmation of this view in the relations of the parts of the so-called chlamydophorous *Heliozoa*, in which the ectoplasm proper is still to be found in the condition of an external envelope, while further on in the developmental history of *Arcella vulgaris*, as described by him, he finds that the ectoplasm which is present in the young stages developes later into the shell.† The author, of course, extends this view as to the nature of the investing skeleton to all the Heliozoa which have skeletons.

Cattaneo also states that he has observed the following. The simple central nucleus, said to possess a deeper brown coloration than the investing entosarc, was divided by a constriction after its nucleolus had become double. One half of the nucleus remained in the centre, while the other wandered to the surface of the entoplasm. Brown granules then became developed in numbers, and were finally scattered through the entosarc; they are regarded by the author as spores. From this observation he believes it necessary to doubt the occurrence of simple fission under any form in such highly-developed

* Atti Soc. Ital. Sci. Nat., xxii. (1880) p. 46 (1 pl.). Cf. Zool. Jahresber. Neapel for 1880, i. p. 155.

† Professor O. Bütschli remarks (Zool. Jahresber. Neapel for 1880, i. p. 155) of this observation, that it justifies an opinion expressed by himself in Zool. Jahresber. Neapel for 1879, as to the probability of an origin of this kind for the shell of *Arcella.*

Protozoa as the *Heliozoa*. In them reproduction takes place by polysporogony; in the Thecolobosa also the ordinary method of reproduction is the generation of numerous germs in the entoplasm. He endeavours to derive the buds observed by R. Hertwig in *Acanthocystis aculeata* from such internal spores as these whose existence he assumes. Naturally, the formation of swarm-spores observed in *Actinophrys* and *Actinosphærium* by Greef and Archer appear to him to support his explanation. He explains the feeble phenomena of motion exhibited by *Acanthocystis flava* as not caused by the pseudopodia, but as due to the mobility of the skeletal elements and to slight dislocations of the surface of the body.

Dimorpha mutans.*—Dr. A. Gruber regards this form as being intermediate between the Flagellata and the Heliozoa; he points out that the systematic position of the former has been a matter of much difficulty, but that Stein is probably right in associating them especially with the Infusoria. With regard to their mode of locomotion, it may be pointed out that in the Protozoa we may have a streaming of protoplasm, the action of flagella, or ciliary movement; there are no fundamental differences between these modes, and in some cases more than one is to be seen in one individual; among these is the organism here described. At one moment appearing to be an *Amœba radiosa*, it suddenly seemed to shoot out a long flagellum on one side; the body then elongated and became oviform, while the pseudopodia began to shorten: two flagella were now seen. After moving about, it suddenly stopped, became spherical, and gave off radially fine pseudopodia, so that it looked like a *Heliozoön*. The cycle of change was again repeated, and was observed in numerous specimens.

The swimming movement is always connected with a rolling round the long axis, which renders observation somewhat difficult; it was, however, possible to see that the margin of the body was often quite smooth, so that it resembled a monad; the protoplasm at the anterior end is then much clearer and free from granules, while the middle portion is dark and contains larger crystalline corpuscles. The nutrient material is collected at the hinder end of the body. There are always two flagella, arising near one another at the anterior blunted pole. No mouth could be seen, and the dark protoplasm completely obscured the nucleus. There is a large contractile vacuole, but there is no cuticle. The pseudopodia would appear to be what Engelmann has called *myopodia*, or to present a fibrillar structure; when a spore of an alga is seized between two pseudopodia, it is almost immediately killed; it is carried to the periphery of the mass of the body and is seized by a broad protoplasmic process, just as in an Amœba; as this may take place at two points of the body simultaneously, it is clear that there is no part specially set apart for the ingestion of nutriment. In four hours digestion is completed. The general protoplasm is soft and not very consistent. On the whole *Dimorpha* presents the characters of a true Heliozoon, but in

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 445–59 (1 pl.)

addition, the two flagella never completely disappear, however much they may be hidden from view; nor is the body perfectly round. The study of its developmental history was, unfortunately, only incompletely carried out.

The author concludes by discussing the doctrine of Bergh that the Cilio-flagellata are the lowest forms; to this he cannot give his adhesion, believing rather that the Rhizopoda stand nearest to formless plasmodia.

Contributions to the Knowledge of the Amœbæ.*—Dr. A. Gruber points out that Auerbach,† starting from the assumption that a membranous boundary was a necessary attribute of a cell, set up a theory, according to which the Amœbæ also, as unicellular creatures, had a membranous envelope. This opinion was refuted by subsequent naturalists, principally Greeff,‡ but with its overthrow some forms of *Amœbæ* and many of the phenomena of their sarcode body, well known to Auerbach, although not quite rightly interpreted by him, seem to have been lost sight of.

The existence of a fine layer of clear protoplasm round the *Amœba* body, which must be penetrated by the pseudopodia, is by no means an insignificant phenomenon, and the author therefore considers it useful to describe another *Amœba* of the same kind (*A. tentaculata*), and to reinvestigate Auerbach's *A. actinophora.*

1. *Amœba tentaculata* sp. n. was found in a small sea-water aquarium, the water and organisms being chiefly derived from the Frankfurt aquarium, but mixed with some from the Baltic and Mediterranean.

It forms a little mass of very variable size, 0·03 mm. to 0·12 mm. In consequence of its greater refractive power, the body stands out luminously from the water, a property which in the protoplasm of all Rhizopoda goes hand-in-hand with greater viscosity. We find the rule confirmed here, for the protoplasm of *A. tentaculata* is, in fact, an extremely tenacious mass, in comparison with that of allied creatures.

Under a power of 80 we can see no movement or change of form, and it is only with high and very high powers that we can recognize an *Amœba* in continual although sluggish change.

Examined in the resting state, it has essentially the same form as *A. verrucosa*; i.e. the whole body is shrunk together, and covered with elevated knobs and deep folds which slowly change their form and position.

In the interior the vital activity of the protoplasm is manifested by a streaming and trembling movement of the fine dark granules with which the sarcode is abundantly furnished.

But while in *A. verrucosa* we miss true pseudopodia, both in the resting state and during flow, we are surprised here by seeing fine

* Zeitschr. f. wiss. Zool., xxxvi. (1881) pp. 459–70 (1 pl.). See Ann. and Mag. Nat. Hist., ix. (1882) pp. 106–16 (1 pl., the use of which has been obligingly allowed us by the publishers).

† "Ueber Einzelligkeit der Amöben," Zeitschr. f. wiss. Zool., Bd. vii.

‡ Greeff, 'Ueber einige in der Erde lebenden Amöben und andere Rhizopoden.'

Mintern Bros lith.

Amœba tentaculata 1-8
— " — actinophora 9-17

protoplasmic filaments at different parts of the body. There are three processes of equal breadth throughout which stand out from the body, sometimes in one place, sometimes in another, and bend to and fro as if feeling about, often curved, but generally pretty straight. At first it seemed that these pseudopodia did not, as in other *Amœbæ*, spring from the protoplasmic body in the shape of fingers gradually becoming thinner, but that small conical elevations of the body served as their base, and that they rose from these with a distinctly marked separation. When they were very numerous they gave the *Amœba* a very peculiar appearance (Pl. III. Fig. 1).

With a Hartnack No. X. (or Seibert's homogeneous immersion) the whole *Amœba* proved to be enveloped by a fine layer of denser substance, a membranaceous cortical layer which causes the periphery of all its humps and processes to appear distinctly double-contoured.

Directly within this firmer envelope lies the soft internal sarcode-mass. If a pseudopodium is to be pushed forth, the enveloping layer must first be broken through. This, however, offers some resistance, and is consequently pushed out in a conical form. An aperture is broken through at the apex of the cone, and the sarcode issues in the form of a thin filament (Fig. 8). The retraction of the pseudopodium was very distinctly observed, after which a new one frequently issued from the same cone.

The pseudopodial cones have a very constant form, and although they can obliterate themselves again completely, this does not always take place after the retraction of the pseudopodium; but very frequently the elevation remains, and a small crater seems to have been formed where the pseudopodium was emitted (Fig. 2 *k*). One specimen had many cones, but all without processes (Fig. 4 *r*), nevertheless they persisted without alteration for a considerable time.

Whether the pseudopodia act as tactile organs or bring in food, cannot be definitely stated. The former, however, appears to be more probable, for in the interior are nutritive materials, such as diatoms, algæ, &c., much too large to be capable of penetrating through the narrow aperture of the cone.

At any rate the animal, notwithstanding its firmer enveloping layer, is able to take in solid materials. Moreover, we know very nearly allied forms such as *A. verrucosa*, which are destitute of these organs, and nevertheless take in such nutritive bodies. Sometimes it appeared as if a slow locomotion was effected by means of the pseudopodia, but only to very inconsiderable distances.

In advancing, *A. tentaculata* employs no special organ any more than its allies which possess a firm cortical layer. The humps and folds gradually disappear, the pseudopodia are for the most part drawn in, and with them the cones, and after the surface has become smooth, there commences a steady flow in one direction, exactly in the same manner as has long been known in *A. verrucosa*, although much slower. In the latter this stage was for a time regarded as forming a distinct species under the name of *A. quadrilineata*.

The longitudinal folds which gave the name to the latter, and which are produced by the strain on the tenacious outer layer acting in one direction, occur here also (Figs. 5, 6, and 7). Along them we see the granules hastening forward in several streams, whilst a clear mass of protoplasm, free from granules, in constant flow, moves on before them. A remarkable circumstance is that on the leading part of the body, pseudopodia with their cones frequently persist, and thus to a certain extent may act as extended feelers (Fig. 7).

While at the end opposite to that which is pushing forward the double contour is distinctly preserved in the outer layer, it disappears entirely on the anterior part (Fig. 6), from which it seems that the first mentioned part of the body retains its toughness, whilst anteriorly all becomes in flux, i. e. the more fluid constituents collect there. Nevertheless, even these still have considerable density, as is proved by the pseudopodia and pseudopodial cones protruded from them, on which, however, no double contour is visible. Frequently a zone of clear protoplasm seems to surround the whole body, and then the double lines are no longer seen anywhere.

EXPLANATION OF PLATE III.

Fig. 1.—An *Amœba tentaculata* with many pseudopodia.

Fig. 2.—Another, 0·12 mm. long, under a higher power (Hartnack eye-piece 3, objective 10 immersion). It shows the cortical zone (*r s*), the pseudopodia (*p s*) on their cones, and at *k* a cone of which the pseudopodium has been retracted (crater).

Fig. 3.—A portion with three pseudopodia highly magnified.

Fig. 4.—A specimen with a number of craters (*k*).

Fig. 5.—A specimen in which the cortical zone is dissolved.

Fig. 6.—A flowing *A. tentaculata*, in which the nucleus (*n*) is very distinctly visible.

Fig. 7.—Another, in which three pseudopodia (*p s*) are still retained on the advancing part.

Fig. 8a.—A pseudopodium with its cone. *m*, the soft interior mass; *r*, the cortex; *p*, the pseudopodium.

Fig. 8b.—A pseudopodium in course of being retracted.

Fig. 9.—An *A. actinophora*, with a distinct cortical layer (*r s*) and a tuft of pseudopodia at one end (Hartnack eye-piece 3, objective 7).

Fig. 10.—Another, with few pseudopodia, distinctly showing how they break through the cortex. (Rather too large in proportion to the following figures.)

Fig. 11.—The same example a short time afterwards. The cortex (*r s*) is almost everywhere liquefied, and has become converted into a clear space (*h*); *n*, the nucleus which is distinctly visible in this state.

Fig. 12.—The same, with the cortex completely dissolved; *v c*, contractile vacuoles.

Fig. 13.—The same, in slow flow in the direction indicated by the arrows; *r s*, the newly reconstituted cortex.

Fig. 14.—Another example, in which the cortex has just become liquefied, but it is still retained at one spot together with two pseudopodia.

Fig. 15.—An *Amœba*, in which the cortex has dissolved before two pseudopodia (*p s*) were retracted. These became liquefied soon afterwards. In this and

Fig. 16 the granular protoplasm is sharply separated from the hyaline zone. This, however, only lasts for a few moments to give place to the state in Fig. 12.

Fig. 17.—An *Amœba*, in which the liquefaction of the cortex has just commenced on one side, treated with osmic acid. The cortex (*r s*) appears finely punctuate, as also the hyaline sarcode; the nucleus at *n*.

Of a nucleus nothing is to be seen in the resting state when the folds obstruct the view of the interior. But if the Rhizopod begins to move when the body flattens, the nucleus becomes distinctly visible (*n* in the figures), as a little disk surrounded by a narrow border, as in most Amœbæ. No contractile vacuole is present, a new proof of the still unexplained fact that this structure is wanting in the marine Rhizopoda.

2. *Amœba actinophora* Auerbach is very small, measuring 0·03–0·04 mm., occurring pretty plentifully in all sorts of receptacles of water in the neighbourhood of Lindau. It is exceedingly suitable for the completion and elucidation of the previous observations.

The first striking point is, that here also the protoplasm is distinctly surrounded by a double contour, the animal appearing as if covered by an envelope. The periphery is for the most part perfectly smooth, and only at one point does the animal extend a larger or smaller number of lobate pseudopodia. In this way the *Amœba* acquires delusively the appearance of a thalamophorous Rhizopod with a closely fitting thin carapace, from the orifice of which processes protrude (see Fig. 9). In this condition the protoplasm in the interior forms a tolerably compact mass, in which there are a number of rather strongly refractive granules.

When the number of the pseudopodia is large, so that a whole tuft of them protrudes at once (Fig. 9), we see nothing of the cortical zone at their place of issue. It is otherwise when only two or three processes are pushed forth. The relations of the marginal layer are then quite distinctly visible, and we find that, just as in *A. tentaculata*, the cortex is pushed out into a cone at the apex of which the pseudopodium makes its way out. Here, therefore, the double contour is also produced by a more tenacious layer surrounding the animal, which must be penetrated by the protoplasmic processes before they can issue (Fig. 14). Even in the previously described form, however, we saw that we have not to do with a persistent membranous structure, but that during the flow of the animal the cortical layer becomes amalgamated with the rest of the sarcode. This is much more distinctly observable in *A. actinophora*. Thus all at once we see how, as the animal changes its form, the pseudopodia are at the same time nearly all retracted, the body becomes flattened, the cortical zone vanishes, and flows into a broad border of clear protoplasm, which surrounds the darker richly granular mass in the centre of the animal (Figs. 11 and 12 *h*). The latter often remains for some time sharply discriminated from the hyaline border (Fig. 17), but the boundary is soon obliterated, exactly as during the formation of an ordinary pseudopodium (Fig. 12). In this state the nucleus (*n*) also becomes distinctly visible, agreeing precisely in its structure with those of other *Amœbæ*.

The melting of the fine cortical layer into the broad clear border does not take place with equal rapidity at all points, so that a part of the *Amœba* often appears sharply limited, whilst another is already surrounded by the clear space (Fig. 11 *r*, *s*). In Fig. 14, for example, is represented an *A. diffluens*, one side of which is already quite liquefied, while on the other half the double contoured enveloping layer is still retained, and on it even two pseudopodial cones with the processes issuing from them are still visible. Fig. 15 is also instructive in another way. There the cortical layer has become fluid, and we see that the two pseudopodia which have persisted, consist of the same hyaline protoplasm as the clear border in which the cortical zone previously sharply separated from it (Fig. 14), has dissolved itself. In the first state, therefore, there would have been an envelope and an endoplasm enclosed by it, and from which the pseudopodia proceeded clearly distinguishable; in the latter, both have become fused into one. Rapidly as the broad, scarcely visible border had formed, it can just as rapidly contract itself again; it shrinks to a certain extent together, until the narrow cortical layer again originates from it.

In this way *A. diffluens* can continually change its aspect completely in one or other of the modes described. Upon what law this power depends cannot be stated definitely; very probably, however, different conditions of pressure come into play in the matter. With a centripetal pressure acting uniformly upon the whole periphery, the more fluid parts of the protoplasm are all pressed into the interior, and only the narrow membranaceous boundary remains. This acquires a firmer consistence by contact with the water, and therefore at the points where pseudopodia issue, it is pushed aside by the latter. If the general pressure ceases, the more fluid constituents again come forth from the interior, dissolve the solidified cortical layer, and form the clear border.

The best illustration of this explanation of the process is furnished by those cases in which a slow flowing forward of the *Amœba* in one direction is taking place (Fig. 14). On the advancing side the fluid constituents are pushed on in front; here all pressure has ceased whilst it acts upon the opposite side, where accordingly the cortical contours are quite distinctly to be seen.

Auerbach had also observed this liquefaction into a disk as is shown by his Fig. 8, but he conceived of it as a phenomenon of expansion in which the cell-membrane also had to take part, but we know that no such membrane exists, and that the envelope is to be regarded only as a transitory concentration of the outermost layer of sarcode, and can at any time dissolve again (Fig. 11).

Dealing with *Cochliopodium pellucidum* of Hertwig and Lesser, the envelope of which represents a true carapace, the author points out that "a perfecting of this structure may be demonstrated from *A. tentaculata* through *A. actinophora* to *Cochliopodium*. It might be conceived that by a further increased tenacity of the cortical zone we shall finally be led to those forms of monothalamous Rhizopods whose envelope forms only a soft membrane closely embracing the sarcode, and which is still so completely at one with the protoplasmic body as to accompany it in all its movements and to be constricted simultaneously in the division.

"Glancing back once more upon the phenomena which confront us in the Amœbiform Rhizopods surrounded by a distinct cortical zone, we shall find in them a welcome elucidation of conditions such as have only been guessed at in the case of other *Amœbæ*.

"In the sarcode body more and less fluid constituents are present; the former we find at the spots which betray a centrifugal movement whether in the pseudopodia or in the advancing part of the flowing Amœbæ (*A. quadrilineata*, *villosa*, *tentaculata*, &c.). The heavier constituents remain behind and are dragged along, and we see them finally break into many cushion-like processes of hyaline protoplasm.

"The pushing forward of the more fluid constituents is effected by the action of pressure upon the opposite side; this is produced by the outermost layer of protoplasm at this part acquiring a tougher consistency by extraction of water. The latter is widened during the flow of the *Amœba* at the posterior end by all sorts of processes, lobes, hairs, &c., which often give the *Amœba* a peculiar aspect and have led to the establishment of distinct species. The sarcode here becomes so tough that as the *Amœba* hastens forward it is drawn into threads, if the expression may be allowed.

"If the direction of movement is reversed the previous posterior extremity begins to flow, and the most tenacious protoplasm occurs on the opposite side. These conditions may be equally well studied on the lobate pseudopodia, as also during the retraction of the pseudopodium on the surface of which all sorts of humps and folds are produced.

"A tougher cortical zone of this kind is actually to be seen in the forms here under consideration. When there is a centripetal pressure acting uniformly it surrounds the whole *Amœba* like a membrane; if the pressure ceases on all sides the *Amœba* flattens into a disk, the cortical zone liquefies and flows into a clear border of more fluid sarcode, but if the pressure acts on one side the liquefaction takes place only on the opposite side, and the mode of movement which may be called the flow of the *Amœba* is produced.

"In the formation of individual pseudopodia (see *A. tentaculata*) it is only a few spots that are subjected to these conditions, and in accordance with this the tougher cortex dissolves only at certain points, making way for the issuing softer sarcode."

Protozoa of the White Sea.*—C. Gobi gives a sketch of Professor Cienkowski's report on his expedition to the White Sea, which appears in the 'Proceedings of the Natural History Society of St. Petersburg' in the Russian tongue, and is illustrated with three coloured plates.

The sea was by no means rich in microscopical organisms, but still a few new and interesting forms were found, and are described and figured, such as *Wagneria mereschkowskii*, a new genus and species of *Protista*, somewhat between *Haeckelina* and *Clathrulina*; several new Flagellata, *Multicilia marina* nov. gen. et sp., having a protoplasmic body of protean form without nucleus or contractile vesicle, but having several cilia; *Exuviaella marina*, also new, with an ovum-like body, flattened horizontally at the top, with two cilia and one or two round marks (*Schildchen*); *Daphnidium boreale* nov.

* Cf. 'Nature,' xxv. (1882) p. 328.

gen. et sp., with a spherical body, prolonged into a curved beak, giving origin to one long cilium. In the dead cells of *Pylaicella* and other Phæosporous Algæ there was found a colourless form of a *Labyrinthula* which had previously been found thriving in the cells of a *Lemna*. Finally, a new Moner, *Gobiella borealis*, which shows a great resemblance to *Vampyrella*, but the green contents seem never to extend into the pseudopodia.

BOTANY.

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

Free Cell-formation in the Embryo-sac of Angiosperms.*—Dr. F. Soltwedel thus sums up the results of a series of observations on this subject on various plants:—

The mode in which the mature nucleus is developed from the homogeneous lump of nuclear substance may be regarded as a formation of vacuoles within it. The contents of the vacuoles constitute the nuclear sap, the nucleoli and the nuclear network and external layer proceeding from the substance of the nucleus. Since in many mature nuclei no external substance is to be recognized, and the nuclear sap is in these cases always sharply differentiated from the surrounding protoplasm, it may be assumed that the nucleus is surrounded by a nuclear membrane, which may be formed by a chemical action either of the nuclear substance or sap upon the surrounding protoplasm.

When the nucleus multiplies, the nuclear substance alone divides, and forms first of all the primary spindle. At this stage the nuclear sap penetrates into the surrounding protoplasm, the nuclear membrane being always absorbed or ruptured. The protoplasm, which now advances to the rods of the primary spindle, surrounds them with a denser layer, and forms in this way the spindle-fibres. These are visible at the poles when the nuclear substance is pressed to the equator. After the halves of the nuclear plates separate, the spindle-fibres remain between them as empty sacs.

Coalescence of the nuclei is effected by the disappearance of the nuclear membranes at the point of contact of the nuclei, and the union of the corresponding constituents. Before the nuclei break up they attain a very considerable size; their membranes are finally absorbed, the nuclear sap mingles with the surrounding protoplasm, and the nuclear substance breaks up, with the formation of vacuoles in the interior, into small pieces, which afterwards deliquesce in the protoplasm. The nuclear membranes are made up of small granules, the composition of which could not be detected.

Structure and Division of the Vegetable Cell.†—In a paper on this subject Mr. J. M. Macfarlane, Demonstrator of Botany in the University of Edinburgh, says that on examining the epidermal

* Jenaische Zeitschr. f. Naturwiss., xv. (1881) pp. 341–80 (3 pls.).
† Trans. Bot. Soc. Edinb., xiv. (1881) pp. 192–219 (2 pls.).

cells of *Ornithogalum pyramidale* he found what seemed a well-marked body inside the nucleolus of a cell, and the same was found on carefully examining the others. The epidermis was quite fresh, and had been stained in alcoholic solution of eosin—an excellent stain for demonstrating minute structure. Numerous other flowering plants were examined, and in the whole of these the new structure was found to be present in the cells of the epidermis, lamina, petiole, stem, and root, as also in Cryptogams, such as *Equisetum limosum*, *Chara*, *Spirogyra*, &c. It is round or slightly oval in outline, and exhibits a clear bounding wall, differentiating it from the substance of the nucleolus. Aqueous solution of logwood reveals the outline well, still better is a solution of iodine; but preferable to either of these is a $\frac{1}{4}$ per cent. solution of eosin in common methylated spirit.*

To this new factor in the vegetable cell the author proposes to apply the term *nucleolo-nucleus*. His investigations led him strongly to the conclusion that the nucleolus is also an invariable element; in fact, all the tissue systems of every plant which have come under his notice in the present connection have been found to be provided invariably with a nucleus, nucleolus, and nucleolo-nucleus, *if the cell is still active*. To ascertain, if possible, the function of these, and their *rôle* in division of the cell, he examined *Ornithogalum pyramidale*, *Scilla bifolia*, *Spirogyra nitida*, and *Equisetum limosum*, and the general results as to division are summed up thus:—

(*a*) In division of the cell the nucleolo-nucleus probably divides first.

(*b*) The nucleolus undoubtedly divides next, and this is followed by division of the nucleus.

(*c*) During division of the nucleus a nuclear plate with nuclear disk is formed occasionally.

(*d*) If a septum is laid down, this is always preceded by formation of a nuclear barrel and cell-plate.

Fertilization of Apocynaceæ.†—F. Ludwig gives a comparative sketch of the various very interesting modes of cross-fertilization in the Apocynaceæ, especially in the genera *Apocynum*, *Vinca*, and *Nerium*, illustrated with woodcuts.

Cross-fertilization and Distribution of Seeds.‡—F. Hildebrand describes the peculiar arrangements for cross-fertilization in *Eremurus spectabilis* (Liliaceæ), in which the perianth withers before either the male or female organ is mature; and in *Rhodora canadensis*, in which self-fertilization is almost absolutely prevented by the position of the stigma.

In *Aponogeton distachyum* the distribution of the seeds is promoted by their possessing air-containing intercellular spaces, by means

* The author also says that he examined a preparation of cerebellum. "In the large multipolar nerve-cells a nucleolus has long been known to exist, but inside many nucleoli this new structure was quite visible. . . . . It has been mentioned before casually, but no importance was attached to it. On looking over various zoological works one finds that it is figured repeatedly."

† Bot. Centralbl., viii. (1881) pp. 183–9.

‡ 'Flora,' lxiv. (1881) pp. 497–504 (1 pl.).

of which they float on the water—an arrangement similar to that found in the white and yellow water-lilies.

Swelling of the Pea.*—F. Schindler has investigated the phenomena of the swelling of the seeds of Papilionaceæ in the case of ten varieties of *Pisum sativum*. He finds all the three stages indicated by Nobbe well displayed in all cases; but each variety was characterized by special peculiarities. The power of swelling was found in general to be in proportion to the specific gravity of the seed. The following may be stated as the general results of the investigation:—

The first penetration of water into the testa of the pea usually takes place through the micropyle, which, with few exceptions, provides an open communication with the external air. Advantage is next taken of the longitudinal fissure of the hilum. The anatomical structure of the layer of stellate parenchyma presents great facilities for swelling; and this absorbs a large proportion of the water admitted through the micropyle, the quantity being sufficient for the first development of the embryo. The spiral vessels of the testa serve as capillary tubes for the conduction of water.

Aril of Ravenala.†—According to Dr. F. R. v. Höhnel, the aril of the seeds of the "traveller's tree," *Ravenala madagascariensis*, is, when fresh, of a beautiful azure-blue colour, and is the only known example of an aril from which an oil is obtained for economical purposes.‡ The author believes that in this instance the bright colour prevents the seed being eaten by birds. The aril is entirely cellular in its structure, the cells being elongated, thin-walled, and with very small intercellular spaces. They are filled with a homogeneous, finely granular, blue mass, consisting of protoplasm and an oil which contains the blue pigment in solution. This substance appears to be peculiar to the species, and of unknown composition.

Structure and Mechanics of Stomata.§—S. Schwendener describes in detail the points of anatomical structure connected with the opening and closing of stomata.

Of the contrivances on which the motility of the guard-cells depends, the most important is that which the author describes as the "epidermal hinge" (*Hautgelenk*), which is placed right and left of the guard-cells in the outer wall of the adjoining epidermal cells. It consists of a thin spot in this wall, never wanting in plants with a thick-walled epidermis, though frequently absent from those where it would be superfluous, viz. where the outer wall of the epidermis is thin. In those cases where the stomata are depressed, they are surrounded by delicate lamellæ of cellulose, which constitute the hinge, attached either to the margins of the fissure, or to the round opening which perforates the outer wall of the epidermis.

The wall which separates the guard-cell from the adjoining

* Wollny's Forsch. aus Geb. der Agriculturphysik, iv. (1881) p. 190. See Bot. Centralbl., vii. (1881) p. 360.

† Oesterr. Bot. Zeitschr., xxxi. (1881) pp. 386–7.

‡ The aril of the nutmeg (mace) yields a well-known oil.—Ed.

§ MB. K. Akad. Wiss. Berlin, 1881, pp. 837–67 (1 pl.).

epidermal cell, if not thin and easily permeable, as is the case where the guard-cells are weak in mechanical structure, has invariably a thin spot which is readily permeable. Where the wall of the guard-cell is otherwise entirely cuticularized, this spot consists of ordinary cellulose. The opposite ventral wall of the guard-cell, bounding the fissure itself, also has always a thin spot. When the cuticle covers the ventral wall of the guard-cells up to the fissure, it is not interrupted at the thin spot. These thin strips constitute a hinge.

Elsewhere the walls of the guard-cells are thickened in a great variety of ways; the outer and inner parts of the ventral surface usually prismatically. By these prismatic thickenings, when the guard-cells become more turgid, a strong elongation of the thin-walled dorsal side is brought about, by which the guard-cells are made to curve, because the thickenings of the ventral wall give them increased power to withstand traction. No curvature of the guard-cells can take place here in consequence of any greater increase in length of the dorsal wall. The motility of such guard-cells appears therefore to be less when mature than when young, when the form of the cells more nearly resembles those with prismatic thickenings. In many plants it is only the thickening ridges which face the interior of the leaf that are capable of curving. The thickenings gradually disappear at their ends, and do not usually coalesce. The guard-cells are often considerably higher at the two ends than at the middle. In many thick phyllodes and evergreen leaves the very narrow cell-walls are bounded above and below by strong thickening stripes, often furnished with prominent cuticular ridges.

Those stomata of which the guard-cells have no cell-cavities are often comparatively immotile, in extreme cases, perhaps, absolutely so.

The mode of motion may be made out by comparing the open and closed conditions of the stomata. For this purpose both vertical and transverse sections should be made; and care must be taken to allow for the increase of turgidity caused by glycerin. The general results of a careful series of measurements is that the size of the guard-cells is greater when the fissure is open than when it is closed.

The movements are caused by increase and decrease of the hydrostatic pressure in the guard-cells. When the turgidity is increasing, the increase of the thin dorsal wall of the guard-cell amounts to about 9 per cent., and the increase in volume of the entire guard-cell to about 17 per cent. The hydrostatic pressure necessary to produce this effect on a cell-wall 1 or 2 μ thick, is respectively that of 5 or 10 atmospheres. It is only when the pressure in the guard-cells exceeds that of the adjoining epidermal cells that the stoma can open. This is effected by a curvature of the guard-cells, caused by the difference in structure of the dorsal and ventral walls, as can be shown experimentally by a caoutchouc-tube.

When there is no tension the stomata are open only in some water plants. In some Monocotyledons (as *Tradescantia discolor*) there is a difference from the normal structure as regards the changes in form, the peculiar structure causing an expansion of the guard-cells in a direction vertical to the surface of the leaf, which increases and decreases with the degree of turgidity. When there is no tension the ventral wall projects; and the thin spot then acts as the hinge between the thickenings.

The result of the movement is (in *Helleborus*) that the anterior chamber of the stoma remains unchanged, while the posterior chamber is greatly narrowed by the closing; the ventral walls of the guard-cells turning on their outer lines of attachment, and bending considerably. The mechanical nature of this process may be determined by observing the change in form of the cell-cavity. When there is no tension, the transverse section of the cavity represents a scalene triangle, pressure tending to change it to an equilateral form, which causes the movement. That this must be the case the author has proved by an experimental apparatus constructed for the purpose.

As regards the purpose of each separate part of the stoma, the two thickening-ridges may be compared to a half-open portfolio; the delicate lamella of cell-wall which unites them to the hinge or back. The uniform strength of the thickening-ridges from one end to the other of the fissure is a contrivance to assist the curvature. When the posterior chamber of the stoma is enlarged by the increased turgidity of the guard-cells, the breadth of the hinge increases, as is essential. Turgidity then causes, firstly, a curvature of the cells, and in the second place an enlargement of the posterior chamber. With increase of age the thickenings become stronger, the opening of the stoma being thus rendered more difficult, and, finally, impossible. In many cases they are ultimately closed by thyllose structures.

The turgidity of the guard-cells is dependent on the influence of light. The fissure was always open (in *Amaryllis formosissima*) after the plant had been exposed for from one to two hours to direct sunlight; while the stomata were always closed when the plant had remained for some time in the dark. Within ordinary variations of temperature heat alone does not cause the fissure to open.

Callus-plates of Sieve-tubes.*—E. Russow has successfully employed aniline blue for colouring the callus-plates of sieve-tubes. An aqueous solution of this pigment is taken up in larger quantities and more firmly held by these plates than by the other parts of the sieve-tubes, out of which it can be washed by water. The same effect was not produced by other aniline dyes, as aniline brown. The fine structure was best exhibited by treating it with chloriodide of zinc containing an excess of potassium iodide either before or after colouring with the aniline blue.

Out of a large number of species examined, Russow found callus-plates in *Alsophila australis*, *Balantium antarcticum*, *Osmunda regalis*, *Equisetum arvense* (but not in *Pteris aquilina*, *Marsilea*, or *Lycopodium*); and in all families of Gymnosperms, Monocotyledons, and Dicotyledons.

In *Abies Pichta* large callus-cushions were found, composed of radially arranged parts with a crystalline appearance, which were evidently doubly refractive. The callus-layers of the sieve-plates of

* SB. Dorpater Naturf.-Ges., 1881, April 23. See Bot. Ztg., xxxix. (1881) p. 723.

Abies excelsa and *Larix sibirica* were partially dissolved by water or glycerin, the parts of the cortex containing them being taken from the stem in April. The sieve-plates of *Equisetum* are perforated by "combining-bundles," which have not been found in true ferns.

The author states that the callus-layers are usually to be found only in the younger or even the youngest parts of the cortex while still in a state of vital activity, and considers it probable that the specific function of sieve-tubes commences with the formation of callus, and lasts only so long as this structure endures.

Phyllomic Nectar Glands in Poplars.*—W. Trelease calls attention to the fact that these glands have been very generally overlooked, and that they have been considered of little value by the systematic botanist. He accounts for this by their being occasionally suppressed, and by their limitation to the earlier-formed leaves. Still, most of the American botanists refer to them, and Michaux figures them in his monograph of the genus. In May 1880, Mr. Trelease's attention was drawn by the action of some bees to examine the leaves of a small aspen. The tree was covered with its newly expanded foliage, and the bees were flying from leaf to leaf; they were seen to be collecting nectar, which was poured out from a double gland at the base of each leaf. These glands were placed on the upper surface of the petiole at its union with the blade. On section and microscopical examination, they showed the usual structure. They were found not to occur on all leaves, but as a rule only on the first half-dozen or less which appear on each branch in the early spring; and later on in the season, when these have fallen off, one may sometimes examine all the leaves without detecting a single glanduliferous one, and this on a species which produced them in abundance earlier in the year. From an examination of the American species it would seem that the greater number possess two or more distinct or confluent glands, situated where the blade and petiole join; and in those few species where none were discovered it is quite possible that a closer examination in the spring-time may show that they exist. Thus on *P. tremula*, the weeping variety, a careful examination in early May failed to show a single gland; but a week or two later, after several days' rain, the young branches grew very rapidly for a short time, unfolding many new leaves, and the first three or four of these on each branch bore large and active glands. The nectar is greedily gathered by insects, chiefly Hymenoptera and Diptera. The most numerous were the ants, who, as is usual in such cases, would fight rather than give up a good position near a nectar-secreting gland. The author regards these glands as protective.

Histology of Urticaceæ.†—Karl von Demeter publishes (in Magyar), an exhaustive account of the histology of Urticaceæ, especially in relation to *Boehmeria biloba*, though reference is made also to many other species.

* Bot. Gazette, 1881. Cf. 'Nature,' xxv. (1882) pp. 327–8.

† K. von Demeter: 'Histology of Urticaceæ, with special reference to *Boehmeria biloba*' (in Magyar), Klausenburg, 1881, 43 pp., 2 pls.

Structure of Podostemonaceæ.*—Prof. E. Warming has carefully studied the anatomy and morphology of this order of flowering plants: especially in the cases of *Podostemon Ceratophyllum* and *Mniopsis Weddelliana* and *Glazioviana*. The following are his chief points:—

Stomata are altogether wanting. The epidermal cells are more or less polygonal; the cuticle is weak. The fundamental tissue consists mainly of parenchymatous cells, usually somewhat elongated longitudinally, especially the nearer they are to the fibrovascular bundles. Their walls are often somewhat collenchymatous, swelling easily in caustic alkali, by which a central lamella is distinctly visible. Intercellular spaces are either entirely wanting or extremely inconsiderable. All the cell-walls consist of pure cellulose, with the exception of the tracheides of the xylem which are slightly lignified. Large quantities of starch are often present in the fundamental tissue. The cell-walls have a strong tendency to excrete silica, which frequently entirely fills up the cell-cavities. This takes place in all the organs, but especially in the epidermis.

The roots are plagiotropous and distinctly dorsiventral, and are hence often flat; they contain sieve-tubes, and nearly always have a root-cap, which is often oblique. They have a great power of regeneration when detached. They attach themselves by means of root-hairs, and of peculiar organs which he terms *haptera*, consisting of protuberances which spring from the under side of the roots.

Each fibrovascular bundle may be traced up into a leaf; every leaf receiving one bundle. They consist, in the stem, of soft bast (sieve-tubes and cambiform) with a few spiral and annular vessels, and are supported by a collenchyma which is especially developed on the dorsal side; its cells have a strong resemblance to true bast-cells. The epidermis of the leaves is not strongly developed; it contains chlorophyll, and some of its cells are prolonged into short hairs. The mesophyll resembles the fundamental tissue of the stem; there is no palisade-tissue. The vascular bundles of the veins are but feebly developed; sieve-tubes were not observed; but, on the other hand, sheaths, composed of true bast-fibres.

Pitchers of Cephalotus follicularis.†—In continuation of his previous researches on the morphology of the pitchers of pitcher-bearing plants, A. W. Eichler traces the development of those of *Cephalotus follicularis* and *Nepenthes phyllamphora*. In the former plant the pitcher is certainly the modified lamina; in the latter possibly, as Hooker believes, an appendicular formation; in a certain sense an excessively developed gland, separated by means of a stalk from the flat basal part which represents the true lamina. Certainly the lid of the pitcher of *Nepenthes* is not the true blade, as many suppose.

Action of Light on Vegetation.‡—Professor N. Pringsheim thus sums up the results derived from his previously recorded observations.

* Vidensk. Selsk. Skr. Räkke, VI. ii. (1881) 6 pl. (French abstract). See Bot. Centralbl., viii. (1881) p. 108.

† JB. K. Bot. Gart. Berlin, i. (1881) pp. 193–7.

‡ MB. K. Akad. Wiss. Berlin, 1881, pp. 504–35.

The primary action of the rays of the sun on vegetation consists in thermic and photo-chemical effects, the influence of which on the separate constituents of the cells is directly recognizable in intense light. The photo-chemical effects relate exclusively to the behaviour of the plant towards the oxygen and carbonic acid of the atmosphere; they are simply changes of intensity in the interchange of gases. These have been fully determined in the absorption of oxygen, less completely in that of carbonic acid. It cannot be then that light produces any other effect on the plant than the thermic and the photo-chemical.

All the action of light on the phenomena of vegetable life, not merely on growth and metastasis, but also the so-called mechanical and vital movements of irritation caused by light, can readily be traced to purely thermic and photo-chemical effects. A more exact knowledge of them requires, however, a special investigation of the behaviour of those constituents of the cell which are sensitive to light, i. e. which are photo-chemically excitable. For an investigation of them, and of their differences from those constituents which are not excitable photo-chemically, the reader is referred to the author's treatises on the functions of chlorophyll and the action of light upon it.*

Production of Heat by Intramolecular Respiration.†—Dr. J. Eriksson has made a series of observations for the purpose of determining the amount of heat, and the length of time for which it lasts, caused by the intramolecular respiration of plants. The experiments were made with the inflorescence of Aroideæ, the flowers of other plants, ripe fruits, germinating seeds, and yeast-cells, care being taken to exclude the access of atmospheric oxygen. In most cases the elevation of temperature under these circumstances did not exceed 0·2° C., while access of air caused a rise of about 1°. With seedlings of lentil the elevation of temperature continued for six days; with buckwheat for two days. In the case of fermenting yeast, however, an elevation of 3·9° was observed, which was not increased by the subsequent letting in of a stream of air. Yeast not in a state of fermentation showed only the slight rise of temperature common to other plants.

Physiological Functions of Transpiration.‡—F. Reinitzer propounds the theory that transpiration is an injurious agent, a necessary evil, in the life of the plant. This view he founds on the fact that transpiration exercises a retarding influence on growth. He regards woody tissue as the cause of rapid movements of water in the plant, rather than as being—according to Sachs's view—formed as the result of such movements.

Metastasis. §—The first volume of Pfeffer's 'Handbook of Metastasis and Metacrasis' (*Stoffwechsel u. Kraftwechsel*) is occupied

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

† Unters. aus dem bot. Inst. Tübingen, i. (1881). See Bot. Ztg., xxxix. (1881) p. 597.

‡ SB. Akad. Wiss. Wien, lxxxiii. (1881) pp. 11-36.

§ W. Pfeffer, 'Stoffwechsel,' 383 pp. (39 figs.). Leipzig, 1881.

with the former of these subjects, and is divided under the following heads:—

The physical properties and molecular structure of organized bodies; including the form of the micella, the mechanical phenomena of swelling, the change of physical properties occasioned by it, and the structure of protoplasm. The mechanical phenomena of metastasis, including the osmotic properties of cells, cuticle, and cork, the osmotic pressure in cells, the power of selection, the specific osmotic capacity of the various organs, and the properties and influence of the soil. The mechanical phenomena of the interchange of gases, including the passage of gases through the cells and cell-walls, stomata and lenticels as conductors of gases, the pressure of gases, &c. The movements of water, including transpiration and the excretion of water. Food-materials, including the production of organic substances and decomposition of carbonic acid gas, the absorption of organic food, the synthesis of nitrogenous substance, and the composition of the ash. The movements of fluid and solid substances, as gums, resins, pigments, and other nitrogenous and non-nitrogenous substances, the constituents of the ash, &c., and the movements which take place during germination. Respiration and fermentation, including the products of respiration, the relation between normal and intramolecular respiration, and the influence of external conditions.

Phosphorescence in Plants.*—L. Crié calls attention to some new cases of phosphorescence in plants. As is known, the flowers of Phanerogams will, under certain circumstances, show phosphorescent gleams, and a few years ago, in stormy weather, the author saw phosphorescence produced by the flowers of *Tropæolum majus*. This emission of light is characteristic of Fungi, especially *Agaricus olearius*, *A. igneus*, *A. noctilucens*, *A. Gardneri*, *A. lampas*, and several other Australian forms, also *Auricularia phosphorea* and *Polyporus citrinus*. The luminous strings of *Rhizomorpha subterranea* are readily observable in the Pontpéan mine, near Rennes. M. Crié also cites *Rhizomorpha setiformis* and a particular form of *Rhizomorpha* which he has observed in the interior of branches of the elder. Having divided a number of these branches in the interior of which filaments of a *Rhizomorpha* were developed, between the wood and the pith, the author was surprised to see very faint gleams produced by the fungus. It possesses a reproductive apparatus which seems by its organization identical with the conidiophorous clavicle of *Stilbum*. Only those filaments that bore abundance of conidia produced phosphorescent gleams. Finally, *Xylaria polymorpha*, gathered on old stumps in a garden, emitted faint white gleams comparable to those produced by phosphorus when oxydizing. In both cases the author considers the phosphorescence to be an effect of the respiration of the conidiophorous portions of *Rhizomorpha* and *Xylaria*.

Transformation of Starch.†—W. Detmer states that the presence of carbonic acid greatly promotes the transformation of starch into

* Comptes Rendus, xciii. (1881) pp. 853–4.

† SB. Jenaisch. Ges. für Med. u. Naturw., 1881, June 17.

diastase in the vegetable cell; and the same effect is produced by small quantities of organic acids as citric acid. The degree of acidity of any particular part of a plant is constantly changing. He believes also that the chief cause of the turgidity of the cell is the presence of vegetable acids, which have the special quality of inducing endosmose, and the presence of which greatly promotes the growth of the plant.

Occurrence of Allantoin in the Vegetable Organism.*—If branches of woody plants covered with buds are cut off and placed in water until the buds unfold, the young shoots and leaves are found to be rich in asparagin, formed most probably by decomposition of albuminoids. E. Schultze and J. Barbieri have undertaken a number of experiments for the purpose of determining whether in these cases, in addition to the amide, other nitrogenous substances are found. By a similar treatment they obtained, besides asparagin, a highly nitrogenous body, which appears to be identical with allantoin both in its composition and in its reactions. This derivative of uric acid was found in no inconsiderable quantity, amounting to from 0·5 to 1·0 per cent. of the air-dried substance.

Excretion of Water on the Surface of Nectaries.†—Dr. W. P. Wilson attributes this phenomenon to osmose, and not to any internal pressure; a view which he supports by the fact that washing the nectaries with water and then drying them with blotting-paper stops the excretion. With regard to the influence of light on the excretion, with some plants no effect was observed, while with others it was greatly increased by direct sunlight.

Determination of the Activity of Assimilation by the Bubbles given off under water.‡—Sachs proposed the method of determining the intensity of the assimilation of water-plants by counting the number of bubbles of gas given off in a certain time. To this plan the objection was made that the bubbles might be the result of some other cause than assimilation. Dr. F. Schwarz has now confirmed the accuracy of Sachs's method, by determining that the presence of carbonic acid in the surrounding water is an indispensable condition to the giving off of the strings of bubbles.

Detmer's Vegetable Physiology.§—The 7th section of Schenk's 'Handbook of Botany' is occupied by a treatise on Physiology by Detmer. The following are the subjects comprised in it:—Food-materials of Plants, including the Process of Assimilation; Origin of the Proteinaceous Substances; Composition of the Ash of Plants; Organic Compounds as Food-materials; the Molecular Forces in Plants; the Movements of Gases; the Absorption of Water; the Movements of Fluids; the Absorption of Mineral Substances; and the Process of Metastasis.

* Berichte der deutsch. chemisch. Gesellsch., xiv. p. 1602. See 'Naturforscher,' xiv. (1881) p. 481.

† Unters. aus dem bot. Inst. Tübingen, i. (1881). See Bot. Ztg., xxxix. (1881) p. 545.

‡ Unters. aus dem bot. Inst. Tübingen, i. (1881).

§ W. Detmer, System d. Pflanzenphysiologie, 1881.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Development of Sporangia.*—K. Goebel continues his researches into the comparative history of development of the sporangia of the higher cryptogams.† These are all characterized by the presence of an "archespore."

The Marattiaceæ were examined chiefly in the example of *Angiopteris evecta*. The sporangia are developed from a group of superficial cells, on the receptacle formed by the superficial cells of the depression of the sorus, corresponding to the placenta of phanerogams. Here also it is the hypodermal terminal cell of the axial row of cells of the rudiment of the sporangium that gives rise to the whole of the sporogenous tissue. By the formation of anticlinal and periclinal walls in the cell above the archespore, it becomes subsequently imbedded in the interior of the tissue. The *Tapetenzellen* arise from the cells which bound the archespore. *Marattia cicutæfolia* and *alata* agree in all essential points.

In *Ophioglossum* it is probable that the sporogenous tissue also proceeds from either a hypodermal or a superficial cell. Cells are produced by periclinal divisions of the parietal cells, which very soon become compressed, and which may also by analogy be termed *Tapetenzellen*. The processes are very similar in *Botrychium* and *Anemia*.

The investigations on *Equisetum* do not confirm Milde's view that the sporangia are produced on the surface of leaves. The apical cell of the sporangial fructification becomes, on the contrary, soon enclosed in a small-celled tissue.

The author enters with considerable detail into the development of the sporangia of the Psiloteæ, especially *Psilotum* and *Tmesipteris*. He agrees on the whole with the view of Sachs and Strasburger that the sporangia are here not the product of the leaves, but are more or less imbedded in the tissue of short lateral axes. The Psiloteæ are, therefore, widely separated from the Lycopodiaceæ by this difference in structure.

In *Selaginella* the sporangia arise from superficial cells of the vegetative apex of the stem, which lie immediately above those from which the apex of the leaf proceeds. The archespore is again the hypodermal terminal cell of the axial row. The radially elongated cells which clothe the inner surface of mature sporangia may be regarded as *Tapetenzellen*. The outermost of them are given off by the archespore; while those near the pedicel are separated from the adjacent cells.

The morphological value of the sporangia of the Archegoniatæ, therefore, varies greatly.

The author then compares the development of the sporangia of the higher cryptogams with that of the pollen-sacs or microsporangia of

* Bot. Ztg., xxxix. (1881) pp. 681–94; 697–706; 713–20 (1 pl.).

† See this Journal, iii. (1880) p. 987.

conifers, and finds a very close correspondence between them. The prolongation of the staminal shield which, in most Cupressineæ, protects the pollen-sacs when young, he regards, from analogy with ferns, as an indusium.

To the view previously expressed that the divisions in the embryo-sac of phanerogams are nothing but divisions of the archespore, he adds two illustrative examples, in *Callitris quadrivalvis* and *Cupressus sempervirens*, in which the reduction in the divisions of the embryo-sac does not go so far as usual.

The author concludes with the following classification of vascular cryptogams and phanerogams.

I. Leptosporangiatæ.
- A. Filices.
  - (1) Homosporæ (Polypodiaceæ, Gleicheniaceæ, Cyatheaceæ, &c.).
  - (2) Heterosporæ (Salviniaceæ).
- B. Marsiliaceæ (Marsilia, Pilularia).

II. Eusporangiatæ.
- A. Filicales.
  - (1) Marattiaceæ.
  - (2) Ophioglossaceæ.
- B. Equisetineæ.
  - (1) Calamites.
  - (2) Equisetaceæ.
- C. Sphenophyllaceæ (the formation of the sporangia resembles that of the heterosporous Lycopodineæ, that of the leaves corresponds to Equisetum).
- D. Lycopodineæ.
  - (1) Lycopodiaceæ.
    - *a.* Homosporæ (Lycopodium).
    - *b.* Heterosporæ (Lepidodendron, Sigillarieæ ?).
  - (2) Psilotaceæ.
  - (3) Selaginellaceæ.
  - (4) Isoeteæ.
- E. Gymnospermæ.
- F. Angiospermæ.

Lenticels of the Marattiaceæ.*—H. Potonié has examined the structure of the lenticels in the leaf-stalk of *Angiopteris crassipes, evecta, Teysmanniana* and *Willinkii*, and *Marattia fraxinea*; and describes those of *A. evecta* in detail. In all the Marattiaceæ the stomata are arranged in rows, in the centre of which lenticels are very commonly found. Their production begins by the walls of one or more stomata, and of the epidermal cells which surround them, becoming brown and dry; the subjacent parenchyma then developing into phellogen by repeated periclinal divisions, and the outermost of the cell-layers also becoming brown and dry. The cell-walls cuticularize, and small interstices appear between the dry cells; the space occupied

* JB. K. Bot. Gart. Berlin, i. (1881) pp. 307–10. See Bot. Centralbl., viii. (1881) p. 70.

by the entire tissue decreases, and the lenticels appear somewhat depressed. This firm dry mass of tissue constitutes, therefore, a protection to that which lies beneath, and its physiological function is the same as that of the lenticels in flowering plants.

Stomata in the Leaf-stalk of Filicineæ.*—H. Potonié states that the arrangement of the stomata in the leaf-stalk of Filicineæ has a direct relation to the anatomical structure of the stem and to the development of the mechanical tissue. The latter is always peripheral, and forms the cylinder of stereome or sclerenchyma; but it may either be hypodermal, or separated from the epidermis by a parenchymatous assimilating tissue. In the former case the stomata are arranged in two rows on the two sides of the leaf-stalk; in the latter case they are distributed over its surface. The former arrangement occurs in *Adiantum*, *Anemia*, *Cyathea*, *Cystopteris*, *Davallia*, *Dicksonia*, *Gymnogramme*, *Lomaria*, *Lygodium*, *Nephrodium*, *Nephrolepis*, *Onoclea*, *Pellœa*, *Polypodium*, and *Pteris;* also in *Hymenophyllum* and *Trichomanes*, as far as relates to the structure of the stem. The second form occurs in *Alsophila*, *Asplenium*, Marattiaceæ, *Marsilia*, and *Todea*, although in the last the parenchyma subsequently passes into stereome.

The author gives the following classification of Filicineæ in reference to this point of structure:—1. Without stomata in the leaf-stalks: Hymenophyllaceæ [Salviniaceæ]. 2. Stomata arranged in two rows: Polypodiaceæ, Cyatheaceæ, Schizæaceæ [Gleicheniaceæ]. 3. Stomata distributed over the surface of the leaf-stalk: Osmundaceæ, Marattiaceæ, Ophioglossaceæ, Marsiliaceæ.

Adventitious Buds on the Lamina of the Frond of Asplenium bulbiferum.†—E. Heinricher has pursued his investigations on this subject, especially as regards the youngest stages, for the purpose of confirming his previous statement ‡ that these buds may originate from a single superficial cell, in which triangularly segmented apical cells were formed. The general result obtained may be stated as follows:—These adventitious buds proceed from a single superficial cell, which proceeds immediately to the formation of a three-sided apical cell. This apical cell is usually the result of three divisions; but cases are depicted in which it results from two and from four divisions respectively. The conclusion of the author is, therefore, at variance with that of A. Zimmermann, that several epidermal cells may take part in their formation.

Anatomy and Classification of Schizæaceæ.§—K. Prantl publishes a preliminary treatise, occupied chiefly with the classification of this tribe of ferns. The following are the genera and subgenera which he adopts:—(1) *Lygodium* (*Palmata*, *Flexuosa*, *Volubilia*); (2) *Mohria*; (3) *Aneimia* (*Trochopteris*, *Hemianeimia*, *Euaneimia*, *Aneimiorrhiza*); (4) *Schizœa*.

* JB. K. Bot. Gart. Berlin, i. (1881) pp. 310–17. See Bot. Centralbl., viii. (1881) p. 70.

† SB. K. Akad. Wiss. Wien, lxxxiv. (1881) p. 115–20 (1 pl.).

‡ See this Journal, ii. (1879) p. 597.

§ Engler's Bot. Jahrb., ii. (1881) p. 297.

Biological peculiarity of Azolla caroliniana.*—M. Westermaier and H. Ambronn have observed that this species presents the peculiarity of throwing off the root-cap from older roots, a great number of hairs being also formed at the apex. An organ is thus produced which resembles the submerged leaf of *Salvinia* in both form and function. A structure which is neither normal leaf nor normal root is formed, in *Azolla* by the metamorphosis of a true root, in *Salvinia* by the abnormal development of an organ which originates as a normal leaf. These root-hairs of *Azolla caroliniana* are produced in moderately regular transverse rows, each proceeding from a segment of the triangular-pyramidal apical cell. This tendency reaches at length the apical cell and youngest segments, and causes the root-cap to be thrown off.

Muscineæ.

Female Receptacle of the Jungermannieæ Geocalyceæ.†—Leitgeb has established the general rule that the female receptacle of the Jungermannieæ always originates in the apex of the shoot, and that wherever archegonia are found on older parts of the stem, they are always products of a lateral shoot. This rule applies to all Hepaticæ; there is only this point of difference, whether or not the apical cell is completely absorbed in the formation of the archegonia. In the former case the receptacle then actually occupies the apex of the axis, which it does not appear to do in the latter case. These two modes of life of the Hepaticæ he terms *acrogynous* and *anacrogynous*. No exception was found to this rule in a very large number of species examined. In all cases the origin of the archegonia at spots distant from the apex of the stem can be traced back to an intercalary lateral shoot. To this case belong the archegonia which spring from the ventral side of the stem in *Calypogeia*, *Geocalyx*, and *Sarcogyne*. But in the family of Geocalyceæ there are some genera in which the archegonial receptacles have not a ventral insertion, but either stand at the apex of a shoot, or the mouth of the fertile tube lies on the dorsal side of the stem.

The most remarkable peculiarities are presented by *Gongylanthus ericetorum*, from Madeira, where all the archegonial receptacles are seated in a fork of the stem, forming also the close of an axis, the apical cell of which is used up in this formation. In contrast to the rest of the European Geocalyceæ, the archegonial receptacles are in this species produced at the apex of normally leafy aerial shoots. They are always preceded by the production of lateral branches, the rapid and early development of which causes their insertion to coalesce completely with the imbedded receptacle, which projects as a protuberance on the ventral side. The consequence of this is that the receptacle is completely pressed aside from the margin of the fork to the dorsal side of the shoot. This displacement must not be regarded as a phenomenon which takes place only on the reproductive shoots; it is a necessary result of the earlier development of the lateral shoot,

* Abhandl. Bot. Ver. Prov. Brandenburg, xxii. (1880) pp. 58–61 (1 pl.). See Bot. Ztg., xxxix. (1881) p. 580.

† SB. K. Akad. Wiss. Wien, lxxxiii. (1881).

and of the hyponasty which belongs also to the apex of the sterile shoots, and which does not afterwards disappear, but becomes fixed in consequence of the origin of the female receptacle, and of the arrest of growth in length. The genus, therefore, presents no difference from the rest of the acrogynous Jungermanniеæ in the position of the female receptacle.

In *Podanthe*, *Lophocolea*, and *Gymnanthe* the receptacle, and hence the fertile tube, are terminal. The normal production of lateral shoots ceases in these genera before the formation of the female receptacle. *Lindigina* presents as a rule the same peculiarities as *Gongylanthus;* while *Marsupidium* more closely resembles in this respect *Calypogeia* and its allies. The reproductive shoots originate in an intercalary manner on the ventral side.

Vegetative Reproduction of Sphagnum.*—C. Warnstorf has observed that when tufts of *Sphagnum squarrulosum* are decapitated by mowing, the stems put out young buds in the neighbourhood of the tufts of branches, each bud possessing a new cone of growth. These buds develope tufts of branches, which for a time derive their nourishment from the parent stem, but soon acquire the power of carrying on existence as separate individuals. This property, together with that of indefinite apical growth, give to the turf-mosses an almost unlimited power of development and reproduction, if only they are supplied with sufficient moisture.

Fungi.

Action of Light on Fungi.†—Professor Karl Regel states that *Pilobolus crystallinus* and *Mucor mucedo* exhibit positive heliotropism in white light, and also in mixed blue and mixed red rays. In one-coloured red light *Pilobolus* also exhibits positive heliotropism. Mixed blue rays produce a much greater heliotropic effect on both species than mixed red rays. Neither the intensity of the light nor the temperature exercises any influence on the kind of heliotropism. While sunlight promotes the development of spores and rapid growth, darkness arrests both. The strongly refrangible are more favourable than the less refrangible rays for both these processes. The hyphæ grow more rapidly in length in white light than in darkness; the less refrangible rays are more favourable to this process than the more refrangible. The formation of sporangia and of spores takes place perfectly normally in *Pilobolus* both in white and in mixed blue and red light, and also in darkness; but most rapidly in white light, next in blue, next in red, and most slowly in darkness.

Chemical Nature of the Cell-wall in Fungi.‡—It is well known that the substance of which the cell-membrane in Fungi is composed does not display the ordinary reactions of cellulose; and it has hence been described as a peculiar substance, under the name "Fungus-cellulose." Karl Richter has determined that this view is incorrect,

* Bot. Centralbl., viii. (1881) pp. 219–20.

† St. Petersburger Naturf. Gesellsch., 1881 (Russian). See Bot. Centralbl., viii. (1881) p. 131.

‡ SB. K. Akad. Wiss. Wien, lxxxiii. (1881).

and that the reason of the failure of the ordinary reactions is the intimate mixture of the cellulose with a foreign substance. In order to eliminate this, it is necessary to treat it for a prolonged period—in some cases several weeks—with potash, and then to wash with a weak acid, after which the blue colouring with chloriodide of zinc is obtained. This treatment was successful with *Agaricus campestris*, *Polyporus Ribis* (?), and *fomentarius*, the sclerotia of ergot, and some lichens; with *Mucor* and *Saccharomyces* it has not hitherto been fully successful; with *Dædalea quercina* the application, in addition, of Schultze's maceration was necessary.

With regard to the nature of the substance which prevents the cellulose-reaction, the author determined, in *Dædalea* and other instances, the presence of suberin, by the formation of insoluble cereinic acid or treatment with nitric acid and potassium chloride. In the mushroom he believes he has also determined the presence of proteinaceous substances.

"Mal nero" of the Vine.*—The vines in the South of Europe, and especially in Sicily, and South Italy, have been attacked, since 1863, by a disease known as "mal nero," which has inflicted great injury upon them; but its exact nature has not heretofore been determined. At the instance of the Italian Government, G. Cugini has now undertaken its investigation, and with the following results:—

The presence of the disease is indicated by the appearance, in the spring, of black streaks and spots on the branches, leaf-stalks, and veins, and on the tendrils and stalks of the branches, penetrating internally to the duramen. It must not be confounded with the anthracnose (*vajolo*) caused by *Glœosporium ampelophagum* (*Sphaceloma ampelinum*).

The disease is caused by a parasitic fungus, a variety of *Sphæropsis Peckiana* Thüm. In the interior of the diseased stems and branches was found abundance of a brown mycelium, which developed especially in the cambium, and between the epidermis and cork-layer. In the parenchymatous tissue of the bark and wood was also found a great quantity of a yellowish-brown granulation, the exact nature of which was not determined. The particles appear to be crystals of calcium tartrate, the result of a hindering effect produced by the fungus on the assimilation of the food-materials absorbed through the root. They are found chiefly in the roots, leaf-stalks, and branches, where the mycelium is comparatively speaking absent.

Roesleria hypogæa parasitic on the Vine.†—G. Le Monnier has found a disease of the vine closely resembling that caused by phylloxera, to be produced by a parasitic fungus which he identifies with *Roesleria hypogæa* v. Thüm. But since that genus was founded on the special form of the spores (which Le Monnier does not

* G. Cugini, 'Ricerche sul Mal nero della vite.' 25 pp. (3 pl.). Bologna, 1881. See Bot. Centralbl., viii. (1881) p. 147.

† Bull. Soc. Sci. Nancy, xiii. (1881) p. 69. See Bot. Centralbl., viii. (1881) p. 47.

confirm), and on the absence of paraphyses, which, however, are present, though difficult to make out, he considers that the genus must be suppressed, and the species arranged under the old genus *Vibrissœa*.

Didymosphæria and Microthelia.*—The identity had been suggested † by Dr. Rehm of the genus *Didymosphœria* of Pyrenomycetes with *Microthelia* of lichens, and the suppression of the former in favour of the latter and older name. G. v. Niessl is unable to accept this view; but regards the former as a true genus of Pleosporeæ, a family made up of genera characterized as under:—

1. *Physalospora.* Spores (ascospores) one-celled.
2. *Didymosphœria.* Spores two-celled.
3. *Leptosphœria.* Spores multicellular, septated transversely only, arranged in one or more rows in the asci.
4. *Raphidophora.* Spores multicellular, septated transversely, arranged in threads or clusters in a straight or coiled bundle in the asci.
5. *Pleospora.* Spores multicellular, septated transversely and longitudinally.

Peronosporeæ and Saprolegnieæ.‡—Professor A. de Bary gives a very detailed description of the sexual and non-sexual organs of the various species included under the Peronosporeæ and Saprolegnieæ.

Pythium de Baryanum is much the most widely distributed of the Peronosporeæ, its thallus being very abundant in living tissues, and in the intercellular spaces, not only in Cruciferæ, but in plants belonging to widely separated natural orders. It is a true parasite, and extremely destructive to the host; but it occurs also in great abundance in the soil, in the form of mycelium, resting conidia, and oospores. It is characteristic of the species that in the formation of the zoosporangia and resting conidia, adjoining portions of the thallus are nearly or entirely and permanently deprived of their protoplasm; the emptied portion usually becoming separated off by a septum. The resting conidia resemble the zoosporangia in every respect except the formation of the neck and of the zoospores. The average diameter of the oogonia is 21–24 μ, and of the oospores 15–18 μ. As soon as the fertilizing tube is formed which carries the contents of the antheridium to the oogonium, the protoplasm in the former separates into two layers, a denser granular central layer which de Bary calls "gonoplasm," and a less dense, nearly homogeneous parietal layer, the "periplasm." The former only appears to participate in the actual process of impregnation.

P. vexans de By. occurs in tubers of the potato which have been partially destroyed by *Phytophthora*, and is closely related to, but apparently not identical with, *P. Equiseti*, found by Sadebeck on the

* Hedwigia, xx. (1881) pp. 161–6.

† See this Journal, iii. (1880) p. 314.

‡ A. de Bary, 'Beiträge zur Morph. u. Phys. der Pilze,' Frankfurt a. M. 1881, pp. 1–71 (6 pls.); and Bot. Ztg. xxxix. (1881) pp. 521–30, 537–44, 553–63, 569–78, 585–95, 601–9, 617–25 (1 pl.).

prothallium of *Equiseta* and on potatoes. The oogonia and oospores are smaller than those of *P. de Baryanum*, the former measuring 15–18 μ, the latter 12–15 μ. It also differs in the mode of germination, and in the abundant formation of zoospores from the freshly formed oospores. It also shows no indication of its thallus penetrating the living tissue of the host; it is a saprophyte, not a parasite.

P. megalacanthum n. sp. is found, along with the first species, on cress; but only on tissue which is already dead, and is hence not a true parasite. The zoospores are of comparatively large size, having an average diameter of 18–20 μ after coming to rest; and 12–15 or more are formed in a zoosporangium. The oogonia are characterized by a large number of vertical conical protuberances, averaging about one-half the length of the radius of the oogonium. The formation of oogonia and oospores takes place chiefly within the tissue of the host. There is a less sharp distinction between gonoplasm and periplasm.

P. intermedium n. sp. is also saprophytic on *Lepidium* and *Amaranthus*. The conidia are formed in rows of from 2–5 by successive abstriction, in a manner different from that known in any other species of *Pythium*. The author has at present failed to detect oogonia and antheridia.

P. proliferum appears on dead insects floating in water that contains algæ; it does not attack living plants. This species closely resembles *P. de Baryanum* in its general morphology, and in the size of the oogonia and oospores. It is characterized by the successive formation of new zoosporangia by a process of prolification. A slightly different form, possibly permanently distinct, is named by the author *P. ferax*.

All the species of *Pythium* hitherto described have more or less globular zoospores; in *P. monospermum*, *reptans*, and *gracile*, the zoosporangium is filiform, the zoospores being formed in the terminal cell of an ordinary branch of the thallus.

P. gracile occurs in dead flies, in water that contains algæ, and can be cultivated on dead plants of *Lepidium* or *Camelina*. The oogonia are very minute, and are formed only in and between the cells of the dead plant. On warm days in summer the oospores are mature in from 24–48 hours after fecundation, and remain then for months in a resting condition. The other forms with filiform zoosporangium are exceedingly similar, and perhaps identical, but appear to be truly parasitic.

Associated with the species already described, and especially with *P. de Baryanum*, there is commonly found one with spiny oogonia, described by Montagne and Berkeley under the name *Artotrogus hydnosporus*. This is the foundation of Montagne's genus *Artotrogus*, formed, as de Bary thinks, on insufficient grounds, chiefly from the negative character of the absence of zoospores, and he proposes for it the name *Pythium Artotrogus*. The antheridia are never, the oogonia rarely, formed from terminal cells of the branch.

Phytophthora omnivora is a parasite on a large number of healthy plants, rapidly killing them, especially in wet seasons, or when otherwise well supplied with moisture, and then living as a saprophyte on the dead tissues, or on dead animals. The oogonia appear to be produced only under water, and only on some of its vegetable hosts. Experiments completely failed to infect the potato or tomato with this species, which de Bary identifies with Hartig's *P. Fagi*, which produces the destructive disease on seedling beeches,* with Schenk's *Peronospora Sempervivi*, and probably with Cohn's *P. Cactorum.* This species agrees in all essential points of structure with the well-known *P. infestans.* The conidia or zoosporangia are considerably larger than in that species, but vary in size, the average length being about 50–60 μ, and the average breadth about 35 μ; their granular protoplasm is of a darker colour. The ripe oogonia are spherical, with a thick, smooth wall, and smaller than in most species of *Peronospora*, about 24–30 μ in diameter. They are usually terminal, and are produced on lateral swellings or branches. In the process of fecundation there is not, as in *Pythium*, the formation of any distinct gonoplasm-layer. This species agrees with *P. infestans* in the peculiarity which distinguishes the latter from all others of *Peronospora*, viz. the successive formation of several conidia on one conidiophore. The two species are, however, undoubtedly distinct, and in all probability the unknown oospores of *P. infestans* resemble those of *P. omnivora* in their smooth surface, and in other particulars. Although the name *P. Cactorum* has the claim of priority for this species, de Bary prefers the more descriptive *P. omnivora.*

In *Peronospora* the history of development of the sexual organs is very similar to that in *Phytophthora.* There is no evident passage of any considerable quantity of protoplasm from the fertilizing tube to the oosphere.

In the species of *Saprolegnia* belonging to the *ferax* group (including *S. monoica*, *Thureti*, and *torulosa*), the oogonia are as a rule terminal on primary or lateral branches. Here also no passage of protoplasm from the fertilizing tube into the oosphere was ever observed. The mutual function of the two organs appears to consist simply in their close contact, and movements of the protoplasm in each of the organs. The tube puts out an appendix which creeps in a sinuous course over the surface of the oosphere; it at length loses its protoplasm, and finally disappears altogether. When an oogonium contains several oospheres, the tube grows from one to another of them (except in the case of *S. torulosa*), and the same process is repeated in each case. In *S. Thureti* and *torulosa* instances frequently occurred of oospores ripening without any contact with the antheridia.

S. asterophora, distinguished by its spiny oogonium, differs in no important point from *S. monoica.* Here again no opening could be detected at any time in the fertilizing tube. Normal oospores are occasionally formed without the co-operation of antheridia.

Achlya prolifera and *polyandra* resemble one another in all essential points. The development of the oogonia presents no essential difference from that in *Saprolegnia monoica.* The most important distinction is that in *Achlya* the protoplasm of the

* See this Journal, ii. (1879) p. 923.

oogonium, before and during the rounding off of the oospheres, is much more coarsely granular and hence less transparent than in *Saprolegnia*. The oospheres are smaller; their number always two or more. No opening of the fertilizing tube is apparent, and its contact with the oosphere is less intimate than in *Saprolegnia*. The oospheres sometimes become invested with a cell-wall when the antheridia have not put out any tubes.

De Bary describes a new species *A. spinosa*, nearly allied to *A. cornuta*, and presenting a very close resemblance to *Saprolegnia asterophora*. It is characterized by the rarity of the production of reproductive organs, especially of zoosporangia. Ripe oospores are occasionally produced without contact from antheridial tubes.

Aphanomyces scaber presents no special point of difference from the other genera of the family as regards the mode of reproduction. The oospores are here also sometimes produced parthenogenetically.

In all the genera described, with the exception of *Achlya*, the structure of the ripe oospore is the same, having a wall consisting of a thicker epispore and a thinner endospore, which encloses a peripheral layer of granular protoplasm, interrupted by a clear speck, and globules of oil. In *Achlya* there is no "fertilization speck." In all, the oospore is often matured without the production of antheridia and fertilizing tubes. In *Pythium*, *Phytophthora*, and *Peronospora*, there is a distinct "periplasm." In *Achlya*, when germination begins, the globule of oil has altogether the appearance of a granular ball of protoplasm. The germinating tube is clothed with a prolongation of the innermost layer of the wall. The entire elongated oospore then becomes a zoosporangium; or the germinating tube does not directly produce zoospores, but, on reaching a suitable substratum, developes into a vegetating thallus of normal size and form, which then produces both zoospores and oogonia; or it may branch and produce several zoosporangia. In some species all three modes of germination occur, while others are limited to one of them.

De Bary considers that the Peronosporeæ and Saprolegnieæ must be retained as two distinct groups, with this as their essential distinction. In the former the oosphere is formed out of a part only of the protoplasm of the oogonium, and is fertilized by the evident absorption of a portion of the protoplasm which passes out of the antheridium; while in the Saprolegnieæ the oosphere or oospheres are formed out of the entire protoplasm of the oogonium; their actual fecundation by contact with the contents of the antheridium has in no case been detected, and in some cases certainly does not take place. The original *Pythium monospermum* of Pringsheim does not agree with the above character, but no doubt from error of observation.

The genera will then be arranged as follows:—

I. Peronosporeæ. *Pythium* or *Artotrogus* (including *Cystosiphon* Cornu), *Phytophthora*, *Peronospora* (including *Basidiophora* Cornu), *Sclerospora* Schröt., *Cystopus*.

II. Saprolegnieæ. *Saprolegnia* (= *Diplanes* Leitgeb), *Dictyuchus*, *Achlya*, *Aphanomyces*.

Of the Peronosporeæ, *Phytophthora* comes nearest to the Saprolegnieæ, while *Pythium* and *Cystopus* are the most remote from them.

Lagenidium, *Myzocytium*, *Ancylistes* Pfitz., and similar forms come very near to *Pythium*, but are distinguished by their production of oospores or zygospores, and may be comprehended for the present under Pfitzer's name Ancylisteæ. *Rhipidium* and *Monoblepharis* are also nearly related to the Peronosporeæ and Saprolegnieæ; the position of the former is uncertain, its mode of fecundation not being at present accurately known; while the latter genus must form by itself the separate group of *Monoblepharideæ*.

Fungi in Pharmaceutical Solutions.*—O. Binz states that the occasional presence of the lower fungi in pharmaceutical solutions is due to the presence of free sulphuric acid, which furnishes the sulphur without which the albuminoids of the fungi in question could not be formed. They withdraw from the sulphuric acid first the oxygen and then the sulphur.

Vegetable Organisms in Human Excrements.†—H. Nothnagel describes the microscopic organisms found in upwards of 800 specimens of human excrements.

Some form or other of bacteria was always found whether the excrements were normal or pathological. The most abundant were sphærobacteria or micrococci, and especially *Bacterium termo*, and these were usually present in enormous quantities; when thin and watery usually in the rod form, when firmer usually in the globular form. All the forms are coloured yellow or yellowish-brown by iodine. *Bacillus subtilis* was also usually found; as also *Saccharomyces*, especially in the excrement of infantile diarrhœa; the most common form resembled *S. ellipsoideus*.

In addition to these, other forms were found which had not hitherto been recognized in the intestines, distinguished by being coloured blue by iodine. The largest of these appeared identical with Prazmowski's *Clostridium butyricum*, the abundance of which was in proportion to the amount of vegetable remains in the excrements. Another smaller form was apparently either a *Clostridium* or Hansen's *Mycoderma Pasteurianum*.

Saccharomyces apiculatus.‡—The first part of E. C. Hansen's researches on the physiology and morphology of alcoholic ferments is occupied with the life-history of *Saccharomyces apiculatus*, with the special object of determining in what form it exists in the periods intervening between its periodical appearances on ripe fruits, gooseberries, cherries, plums, &c., in the summer. The species presents special facilities for this purpose, in consequence of its specific characters being more distinctly marked than those of any other ferment.

Hansen affirms that *S. apiculatus* is found in the summer on ripe

* Wiener Medicinische Presse, 1880. See Bot. Centralbl., viii. (1881) p. 174.
† Zeitsch. für klin. Med., 1881 (1 pl.).
‡ Meddel. fra Carlsberg Labor., 1881, pp. 159–84 (3 pls.). See Bot. Centralbl., viii. (1881) p. 6.

sweet succulent fruits, rarely on unripe fruits or in other localities; from these it is spread by the wind. By rain or the falling of the fruit it is carried to the ground, where it hibernates, repeating the cycle in the next summer.

S. apiculatus produces two kinds of gemmæ, the typical citron-shaped, and others more or less oval, the former being produced earlier, the latter later. Its power of fermenting is much less than that of *S. cerevisiæ*, producing only one volume of alcohol where that species would produce six. It differs from other species of *Saccharomyces* in this respect, that it does not produce invertin, and therefore cannot invert saccharose, nor cause alcoholic fermentation in a solution of it. It exerts an unfavourable influence on the production of *S. cerevisiæ*.

Etiology of Malarial Fevers.*—Dr. G. N. Sternberg was instructed by the National Board of Health (U.S.A.) to repeat the experiments of Klebs and Tommasi-Crudeli made near Rome, whereby they believed they had discovered *Bacillus malariæ*.

The author carried out his experiments in the vicinity of New Orleans, where a great number of minute algæ, including bacteria of various forms, are found upon the surface of swamp-mud, as well as in the gutters within the city limits.

Many of these forms may be successfully cultivated in fish-gelatine solution (method of Klebs), and this fluid, previously innocuous, was found, as the result of inoculation with the organisms, to acquire pathogenic properties obviously due, directly or indirectly, to the presence of the bacteria; for, if they are excluded, the fluids may be kept indefinitely without undergoing change, and are innocuous when injected beneath the skin of a rabbit.

Some of the organisms from swamp-mud, gutter-water, and human saliva were found to be capable of multiplying within the body of a living rabbit, and the fluids and organs containing them (blood, serum from cellular tissue, spleen, &c.), possess virulent properties. In other words, an infectious disease is produced which may be transmitted from animal to animal by inoculation. There were some which closely resembled and, perhaps, are identical with the *Bacillus malariæ;* but there is no satisfactory evidence that these, or any other of the bacterial organisms found in such situations, when injected beneath the skin of a rabbit, give rise to a malarial fever corresponding with the ordinary paludal fevers to which man is subject.

The evidence upon which Klebs and Tommasi-Crudeli have based their claim of the discovery of a *Bacillus malariæ* cannot, the author considers, be accepted as sufficient; (*a*) because in their experiments and in his own the temperature-curve in the rabbits operated upon in no case exhibited a marked and distinctive paroxysmal character; (*b*) because healthy rabbits sometimes exhibit diurnal variations of temperature (resulting apparently from changes in the external temperature), as marked as those shown in their charts; (*c*) because changes in the spleen such as they describe are not evidence of death

* 'National Board of Health Bulletin,' Supplement No. 14. Washington, 23rd July, 1881. 11 pp. and 4 pls.

from malarial fever, inasmuch as similar changes occur in the spleens of rabbits dead from septicæmia produced by the subcutaneous injection of human saliva; (*d*) because the presence of dark-coloured pigment in the spleen cannot be taken as evidence of death from malarial fever, inasmuch as this is frequently found in the spleen of septicæmic rabbits.

While, however, the evidence upon which Klebs and Tommasi-Crudeli have based their claim to a discovery is not satisfactory, and their conclusions are shown not to be well founded, there is nothing in Dr. Sternberg's researches to indicate that the so-called *Bacillus malariæ*, or some other of the minute organisms associated with it, is not the active agent in the causation of malarial fevers in man. On the other hand, there are many circumstances in favour of the hypothesis that the etiology of these fevers is connected, directly or indirectly, with the presence of these organisms or their germs in the air and water of malarial localities.

The truth or falsity of this hypothesis can only be settled by extended experimental investigations; and while further experiments upon animals may lead to more definite results, it seems probable that the *experimentum crucis* must be made upon man himself, isolating and cultivating the various organisms found in malarial localities, and experimentally investigating the physiological action of each when taken into the stomach or respired in a dry state by healthy individuals. The converse method should also be tried of studying the bacterial organisms found in the mouth and alimentary canal of persons suffering from malarial fever, compared with the common forms found in the same situation in the healthy state.

Aktinomykosis, a new Fungoid Cattle-Disease.* — Under the name Aktinomykosis or Strahlenpilzerkrankung, Johne describes an infectious disease which attacks the tongue, throat, &c., of cattle, and which he attributes to a hitherto undescribed bacterial organism to which he gives the name *Aktinomyces*. The author is not able to assign a systematic position to this organism. It commences with an unseptated mycelium, probably originating from micrococci, which swell up into pear- or club-shaped conidia. When collected into masses it not unfrequently becomes hard and calcified.

Infection by Symptomatic Anthrax.†—Messrs. Arloing, Cornevin and Thomas give some results of their intravenous method of inoculation ‡ applied under the authority of the French Government, and of other methods which they have tested. Of these other methods (1) that by the digestive passages has not hitherto been found to produce the disease; (2) that by the respiratory cavities causes a merely abortive malady; (3) that by injection into the connective tissue (either dermal, subcutaneous, or intramuscular) of infinitesimal quantities of virus results in abortive symptoms; with a medium dose, a trifling local disturbance is set up, but more lasting general effects are also produced

* Deutsch. Zeitschr. für Thiermed., viii. (1881) pp. 143-92 (3 pls.). See Bot. Centralbl., vii. (1881) pp. 338.

† Comptes Rendus, xcii. (1881) pp. 1246-9.

‡ See this Journal, i. (1881) p. 95.

in the form of one or more symptomatic tumours at points remote from the place of inoculation; with a very strong dose a tumour immediately appears at this point, the general condition of the patient becomes rapidly serious, and if life lasts sufficiently long, one or more tumours may arise in different parts of the muscles. (4) The results of the intravenous process of injection similarly differ with the amount of virus employed. With a minute quantity general disturbances are produced, which disappear in two or three days, leaving the subject proof against the effects of further inoculation; this is caused by an abortion of the anthrax. With a considerable dose, symptomatic anthrax is fully developed, and tumours appear, invariably causing death.

These different modes in which the poison may be seen to act are thus explained. In the case in which intravenous injection is not fatal the bacterium probably multiplies in the blood, but is prevented by the endothelium of the vessels from entering the connective tissue. The serious consequences which always follow introduction of the poison into the latter tissue—extending to the production of a local tumour, even after a preventive inoculation by intravenous injection—show this to be really the point at which the virus attacks the system. When tumours follow intravenous injection, the bacterium must have passed in some way into the connective tissue, whether by rupture of other coats or otherwise. The abortive result of inoculation by way of the respiratory system, as well as by way of the veins, is due to the same cause, viz. the penetration into the blood of the bacterium through the lining-epithelium and its development in this harmless position.

A short account of some public experiments performed by the same three investigators at Lyons is given by Bouley.* The first series were intended to show immunity against symptomatic anthrax produced by previous intravenous inoculations at different periods. Thus a ram inoculated in the thigh with 5 cc. of the virus died in two days, but a calf, vaccinated fourteen months previously by intravenous injection, showed not the smallest sign of evil effects after injection of 1 mm. in the same manner as in the former case; the same immunity was exhibited by another calf inoculated with 5 mm. eleven months after vaccination; so also with a calf sixteen days old whose mother had been inoculated twenty-seven days after the commencement of gestation (six months before the birth of the calf). An ewe, vaccinated fifteen days previously by injection into the trachea, behaved similarly on injection of 5 mm. into the thigh. A second series of experiments showed the refractory behaviour of certain animals towards the disease; thus subcutaneous and intramuscular injections produced no effects on a pig, a white rat, a dog, and a rabbit, but the same operation performed at the same time killed a six months' calf.

The method of vaccination here adopted differs from that employed by Pasteur against the other form of anthrax (bacteridian anthrax) in not employing a mitigated form of the virus, but introducing the virus in its natural condition into surroundings (i.e. the blood-vessels) not so

* Comptes Rendus, xcii. (1881) pp. 1383-7.

favourable to its development as other parts of the body. The value of the method has been proved by the subjection of 244 animals to its action.

Experiments on Pasteur's Method of Anthrax-Vaccination.*— In his own name and the names of Messrs. Chamberland and Roux, L. Pasteur gives a summary report of a series of experiments made by them in May and June 1881, near Melun (Seine-et-Marne), at the request of the Agricultural Society of that place, in order to demonstrate the vaccinating power of a modified form of anthrax virus, as already described.†

Fifty-eight sheep, of different breeds, ages, and sexes, two goats, eight cows, a bullock, and a bull having been placed at their disposal, they set aside 10 of the sheep and inoculated 24 of the remaining 50, together with 1 goat and 6 cows, with a mitigated form of anthrax virus, and then, after 12 days, with a stronger solution. After a further interval of 14 days, the 31 vaccinated animals, together with the 24 sheep, 1 goat, and 4 oxen still remaining unvaccinated, were inoculated with a very deadly form of anthrax virus, vaccination being carried out alternately on vaccinated and unvaccinated animals. The company, including numerous local and departmental authorities and professional men, were assembled after two days to witness the results of the experiments. All the subjects of the preliminary inoculation were found, to all appearance, in good health (one died subsequently from a cause other than anthrax), but of the others, 21 sheep and the goat had already perished from the disease, 2 more sheep died in the presence of the spectators, and the twenty-fourth died at the close of the day. None of the oxen died, but all developed large swellings round the point of inoculation, and their temperature rose 3°. A large number of those present expressed their conviction of the importance of the method adopted.

Professor Milne Edwards ‡ has compared some of the facts brought forward by M. Pasteur with the phenomena of alternation of generations exhibited by some *Hydrozoa*, and suggested that experiments should be made to ascertain whether in this case, as in that of the septic organisms described by M. Pasteur, variations in the temperature or in the amount of air dissolved in the water, might be made to produce whichever stage of these animals might be required.

Some experiments, as reported by Bouley,§ were also made publicly at Chartres, with the view of testing the principles laid down by M. Pasteur, and supported by his experiments at Melun. They differ from those experiments in employing infected blood for the inoculations instead of artificial growths of the virus. Thus 19 sheep already inoculated, together with 16 which had not been inoculated, were all injected with half a syringeful each of a mixture of blood and splenic pulp taken from a sheep which had just died of anthrax; 15 of the 16 unvaccinated sheep died within 3 days of the operation; the 19 which

* Comptes Rendus, xcii. (1881) pp. 1378–83.
† See this Journal, i. (1881) p. 499, &c.
‡ Comptes Rendus, xcii. (1881) p. 1383.
§ Ibid., xciii. (1881) pp. 190–2.

had been vaccinated showed no sign of ill-health. The method of vaccination is thus proved to be as efficacious against virus produced naturally as against that produced by artificial means.

Duration of Immunity from Anthrax.*—H. Toussaint bears testimony to the finality of M. Pasteur's recent investigations on this subject. He draws attention to one or two minor points yet unsolved, viz. the *duration* of the immunity against the disease, and the *power of inheriting* this immunity which is possessed by animals. The duration is said to vary directly with the severity of the first attack, and inversely with the resistance of the animal to the disease; for certain lambs and ewes which had suffered severely from the effects of a first inoculation had preserved their immunity up to the time of writing (12 months), and the ewes had transmitted it to their offspring; while of certain 20-month lambs and old ewes which were first vaccinated with a weaker virus than in the preceding case, and which had resisted an inoculation made a month later, some of the ewes were overcome by the effects of a third inoculation made four months later, while the 20-month lambs survived. The fact of inheritance of the immunity is shown by the absence of any evil results of inoculation of lambs of one month which were born of vaccinated ewes; this is a genuine case of inheritance, which cannot be said with equal truth of lambs born of parents inoculated during gestation, for in this case the lamb *in utero* forms practically part of its parent.

New Method of Vaccination for Fowl-cholera.†—H. Toussaint supplements M. Pasteur's researches in this subject by experiments showing new methods of mitigating the virulence of the poison, and confirming his own previous opinion as to the identity of septicæmia and fowl-cholera. In one case rabbits inoculated with blood infected with anthrax died in 7 or 8 hours of septicæmia, pigeons died from its effects in from 1 to 4 or 5 days, fowls inoculated from the pigeons also in from 1 to 4 or 5 days. The bacterium of the disease exactly resembles that of fowl-cholera, and all the symptoms and lesions are precisely similar with both the diseases. In another set of experiments, consisting in inoculating fowls directly with blood from rabbits which had died of septicæmia, the fowls were not killed, but proved to have undergone a vaccinating action, being afterwards proof against both fowl-cholera and septicæmia. To secure this result it is only necessary to vaccinate at the end of the wing. M. Toussaint is inclined to explain the fowl-cholera as produced by certain bacteria whose development is favoured by the presence of putrefying organic matter.

Rabies.‡—This obscure subject has been now approached by the famous experimenter on germ-diseases, L. Pasteur, in conjunction with Messrs. Chamberland, Roux, and Thuillier. The view long supported by Dr. Duboué, that the central nervous system, and above all the medulla oblongata connecting the spinal cord with the cere-

* Comptes Rendus, xciii. (1881) pp. 163–4.
† Ibid., pp. 219–21.
‡ Ibid., xcii. (1881) pp. 1259–60.

brum and cerebellum, is the seat of the development of the disease, had been disputed by Prof. V. Galtier, who found indications of virus only in the lingual glands and on the mucous membrane of the mouth and pharynx, and not in the above-named parts of dogs affected with the disease. Pasteur and his companions have, however, often successfully inoculated the medulla oblongata, the cerebro-spinal fluid, and the frontal portion of one of the hemispheres. The period of incubation before manifestation of its effects has hitherto been found to be uncertain, and often long, but this period can now be diminished by inoculating the surface of the brain directly with pure brain substance removed from a mad dog: in this case, the symptoms of madness, either under its silent or furious form, appear within a fortnight of the operation, and death ensues in less than three weeks from the same date. This method has never—as in so many other cases—failed in producing the disease.

The results of some experiments * with the active elements of rabies have led Prof. Galtier to some important conclusions. Six sheep and four rabbits inoculated at different times with this poison by hypodermic injection all died from its effects; while out of nine sheep and one goat inoculated by intravenous injection none succumbed, but on the contrary, all successfully resisted the effects of subsequent inoculations. Of five rabbits which received as a draught some saliva infected with virus and mixed with water, only two died. The conclusions deduced are:—(1) Intravenous injection of the poison of rabies into sheep does not produce the disease, but seems to confer immunity against it; (2) introduction of the poison into the digestive organs is fraught with danger. Galtier has reasons for suspecting that intravenous injection, practised the day following a bite or inoculation, or even the next day, will prove effectual in warding off the malady.

Lichenes.

Nutrition of Lichens.†—G. Egeling disputes the statement that when lichens grow on apparently smooth surfaces, as quartz, glass, &c., they are true "epiphytes." On even the smoothest surface, there are always irregularities which allow of the accumulation of dust; and from the substances which collect in this way, the lichen obtains its nutriment, until it is able to decompose the hardest and smoothest substances, even glass or oxide of iron.

Thallus of Usnea articulata.‡—According to A. Jatta, the thallus of this lichen consists of three distinct layers, viz. (1) a central, continuous, compact, elastic, very resistant tissue, the *medullary layer;* (2) a much laxer and readily distinguishable tissue, composed of branched hyphæ and gonidia, the *gonidiferous* layer; and (3) a membranous sheath, very delicate and almost inelastic, the *cuticular layer*. The interrupted or jointed thallus, characteristic of the species, is the result of the unrolling of the spiral of the medullary filaments, which causes their rapid elongation, in contrast to the very slight

* Comptes Rendus, xciii. (1881) pp. 284–5.
† Oesterr. Bot. Zeitschr., xxxi. (1881) pp. 323–4.
‡ Nuov. Giorn. Bot. Ital., xiv. (1882) pp. 53–9.

elasticity of the cuticular layer and the looseness of the gonidiferous layer.

The author objects to the ordinary term "gonidial layer" as applied to lichens, seeing there is no distinct layer composed entirely of gonidia. The gonidia of *Usnea articulata* are of the form referred by Bornet to *Protococcus*. In the older part of the thallus they are perfectly free from hyphæ, and are grouped in various ways in the outer part of the gonidiferous layer; but in the younger part of the thallus the hyphæ are composed of shorter cells and assume a more contracted appearance, and the gonidia are often to be found adhering to their apices.

Algæ.

Symbiosis of Lower Animals with Plants.*—The relations which subsist between the different organisms which live upon, or within each other, are very various; for the one, in its capacity of parasite or companion or guest of the other, exercises on its host an influence which is in some cases injurious, and in others advantageous to the vital conditions of the latter. Many instances of this life in common, or *symbiosis*, are known among animals as well as plants, but the cases of symbiosis between animals and plants are less well known; and in regard to these, K. Brandt has made some interesting communications to the Physiological Society of Berlin, of which the following is an extract.

Chlorophyll, which occurs in all plants except the Fungi, is known to occur in the animal kingdom also—in Rhizopoda, ciliate Infusoria, fresh-water Sponges, the tentaculate Polypes, and many marine and fresh-water Turbellaria. In all these the chlorophyll is present in the form of sharply defined, oval, or round granules, identical with its form in plants. Three contradictory views have been held with regard to the presence in animals of chlorophyll: (1) that the green particles are true chlorophyll-granules, (2) that they are not produced by the animals themselves, but must be considered as parasites, (3) that in the case of the Protozoa, at any rate, the green masses are merely parts of vegetable organisms which have been absorbed after being submitted to digestion. Direct observation has not yet decided the question. In his 'Natural Conditions of Animal Existence,' Semper gives a critical sketch of the investigations which have been made, and comes to the conclusion that the green particles should be regarded either as endogenous products of the animal, or as commensals, and he considers the latter opinion the most probable one. The author has accordingly made experiments with microchemical reagents in order to determine whether the green bodies consist simply of chlorophyll combined with a fundamental substance, or whether they contain colourless protoplasm as well, and whether they have a nucleus, and are invested by a cellulose membrane, also whether they are physiologically independent, or continue to live after the death of the animals in which

* Verhandl. Physiol. Ges. Berlin, 1881–2, p. 22. Cf. Naturforscher, xv. (1882) pp. 15–17; and Rev. Internat. Sci. Biol., v. (1882) p. 149–52.

they occur, and whether it is possible to infect an animal which has no chlorophyll, by means of a fragment of one which does contain it.

The morphological investigations were carried out upon *Hydra*, *Spongilla*, a fresh-water Planarian, and a variety of Infusoria. The green bodies were isolated by crushing the animals and were then examined with high powers, and it was found that they are not of a uniform colour like the chlorophyll-bodies of plants, but contain hyaline protoplasm. Treatment with hæmatoxylin always reveals a definite cell-nucleus, and the same is the case if the animals are first killed by 0·2 per cent. chromic acid, or 1 per cent. per-osmic acid, then freed from chlorophyll by alcohol, and finally treated with solution of hæmatoxylin. These characters prove that what have been described as chlorophyll-corpuscles in animals are really unicellular beings, morphologically independent, which Brandt describes as two new genera of Algæ, *Zoochlorella*, and *Zooxanthella*, with several species; the first-named are green, and are met with in animals belonging to the Protozoa, the Sponges, the Hydrozoa and the Turbellaria; the second are yellow, and are found in some Radiolaria, certain Hydrozoa, and some Actiniæ.

Their physiological, as well as their morphological independence can also be established. Thus, if specimens of *Zoöchlorella* are isolated, they do not die, but live for some days, and even weeks, and when exposed to the light are able to develope starch-grains. Inoculation-experiments show besides that the species of *Zoochlorella* also differ physiologically *inter se*. Green bodies isolated from *Spongilla* and brought into contact with Infusoria devoid of chlorophyll, although in many cases taken in, were unable to persist in the latter animals; they were either digested or expelled without undergoing any alteration. On the other hand, Infusoria devoid of chlorophyll were successfully inoculated by *Zoochlorellæ* from a dead *Hydra viridis*. Many *Ciliata*, absolutely without green corpuscles, absorbed the parasitic forms of the *Hydra*, and kept them for a long period.

With regard to the question of the origin of the chlorophyll, Brandt concludes that the animal organisms do not themselves produce it, it being found nowhere but in true plants, so that when met with in animals, it owes its existence to parasites. He describes in the following terms the results to which his experiments have led him: "In making use of the expression 'parasites,' for the yellow and green algæ, I have been actuated by the desire of abbreviation, as well as by the fact that morphologically the algæ have almost the appearance of parasites on animals. Physiologically, they cannot be regarded as parasites. They cannot be compared with the parasitic fungi, the *Tæniæ*, &c., for these derive their subsistence from their hosts alone, form no nutrient matter themselves, and give out still less, while the species of *Zoochlorella* and *Zooxanthella* have the power of producing organic materials (water and carbonic acid) themselves, in the same way as true plants. At first sight, one would expect them not to remove organic matters from their host, but rather to supply them to the latter. What, however, really takes place, and to a very large extent, is shown by the following observations:—

"(1) In carefully examining large colonies of Radiolaria, I have not found, either in their gelatinous matter or in its neighbourhood, any foreign bodies which had undergone digestion. Inasmuch as they require, by reason of their very considerable bulk, large quantities of nourishment, and as they are absolutely destitute of any power of manufacturing organic substances out of water, carbonic acid, and ammonia, they cannot be kept alive by any other means than the yellow cells which they harbour in large quantities. (2) I have been able to keep the colonies with ease by placing them in well-filtered sea-water: under these conditions they are deprived of all possibility of nourishing themselves, like true animals, with solid organic substances. (3) I have kept *Spongilla* in filtered river-water for the same length of time. Even when the water has been filtered daily, they have flourished wonderfully. But whenever the vessel was placed in a half-darkened spot, they regularly died. Light is absolutely necessary to them.

"This proves, then, that *Zooxanthella* and *Zoochlorella* contribute to the support of their hosts. As long as the animals contain but few or no green or yellow cells, they are nourished like true animals, by the absorption of solid organic materials; as soon as they contain a sufficient amount of algæ, they are nourished like true plants, by assimilation of inorganic materials. They ought to resume their animal mode of nourishment when the algæ withhold their functions, in the absence of light. They perish if they do not then again adapt themselves to the mode of alimentation which properly belongs to them.

"The researches of botanists have brought to light two different ways in which algæ may live in connection with other vegetable organisms. Firstly, algæ are found living like "lodgers" in other chlorophyllaceous plants. Secondly, according to Schwendener, they live in companionship with fungi, and with them form lichens. In the first case the parasitic algæ usually behave indifferently in relation to the conditions of assimilation adopted by their hosts. The algæ are nourished like the plants in which they live, by assimilation of organic matter. In the lichens, the algæ furnish the nutritive matter to the fungi, which live parasitically upon them. The algæ manufacture organic substances out of inorganic substances, and the fungi utilize them.

"The association of algæ and animals is an analogous case, but nevertheless differs from it. In the green and yellow animals the same phenomenon usually occurs; the algæ manufacture organic substances from inorganic substances, and the animals make use of them. But while in the lichens we find true parasites (fungi) associated with algæ, in the green and yellow animals we find a *symbiosis* of algæ with independent animals, habituated to an independent existence. The animals (Phytozoa as they may be termed) renounce their independent life and allow themselves to be supported entirely by their parasites, when once the green or yellow algæ have entered their tissues and have multiplied there sufficiently. They absorb no more solid organic substances, although they are perfectly able to do so, but are entirely comparable, from the morphological point of view, to animals devoid of chlorophyll. This life of algæ in common with animals is one of the strangest things which can be conceived. Morphologically it is the algæ which are the parasites, but physiologically the animals."

"Yellow Cells" of Radiolarians and Cœlenterates.*—Mr. P. Geddes was also simultaneously (and independently) working at the same subject as that which had engaged Herr Brandt's attention (forming the subject of the preceding note), and in a communication to the Royal Society of Edinburgh he deals with the vexed question as to the nature of the "yellow cells" also, presenting an interesting aspect of the economic inter-relations of the animal and vegetable kingdoms.

The author's researches on animal chlorophyll had already shown that such animals as *Convoluta*, *Hydra*, and *Spongilla* vegetated by their own intrinsic chlorophyll; and he now shows that certain Radiolarians and Cœlenterates vegetate, as he terms it, "by proxy, by rearing copious crops of Algæ in their own tissues, and profiting by their vital activities." Cienkowski and others have already contended that the "yellow cells" in question were algæ, for the reason, among others, that they continued to live and multiply long after the death of the animal, but the subject was obscured by contradictions. After repeating the observations of Cienkowski on the Radiolarian yellow cells, the author undertook an independent examination, which established their character as true algæ. Not only is their mode of division thoroughly algoid, but starch, as described by Haeckel, is invariably present. The cell-wall is of true vegetable cellulose, and the yellow colouring matter is the same as that of diatoms. In *Velella*, in sea anemones, and in a Rhizostome Medusa (*Cassiopeia borbonica*), similar organisms were found.

Alluding to the methods of examination, Mr. Geddes says that the failures of former observers in obtaining these reactions have been simply due to neglect of the ordinary botanical precautions. Such reactions will not succeed until the animal tissue has been preserved in alcohol and macerated for some hours in a weak solution of caustic potash. Then, after neutralizing the alkali by means of dilute acetic acid, and adding a weak solution of iodine, followed by strong sulphuric acid, the presence of starch and cellulose can be successively demonstrated in the same preparation. "Thus, then, the chemical composition, as well as the structure and mode of division, of these yellow cells are those of unicellular algæ. I therefore propose for this alga the generic name of *Philozoon*, and distinguish four species differing slightly in size, tint, mode of division, &c., to which the names of *P. radiolariarum*, *P. siphonophorum*, *P. actiniarum*, and *P. medusarum*, according to their habitat, may be conveniently applied."

The mode of life and functions of the organisms are fully dealt with. Reminding us that the colourless cells of a plant share the starch formed by the green cells, Mr. Geddes urges that it is impos-

* Nature, xxv. (1882) pp. 303–5.

sible to doubt that when the vegetable cell dissolves its own starch, some must needs pass out by osmosis into the closely enveloping protoplasm of the surrounding animal cell, which possesses abundance of amylolytic ferment. Further, the nutritive functions of the animal gain by digesting the *Philozoon* at its death. On the other hand, the carbonic acid and nitrogenous waste produced by the animal cell are necessities of life to the alga, which in removing them performs an intracellular renal function. Yet further, during sunlight the alga constantly evolves nascent oxygen into the surrounding animal protoplasm, and so we have foreign vegetable chlorophyll performing the respiratory functions of native animal hæmoglobin, and the resemblance becomes closer when we bear in mind that hæmoglobin frequently lies as a stationary deposit in some tissues like the tongue of certain molluscs and the nerve-cord of *Aphrodite* and Nemerteans.

Thus, then, "for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient active vitality to manure it with abundance of carbonic anhydride and nitrogenous waste, yet of sufficient transparency to allow the free entrance of the necessary light. And conversely for an animal cell there can be no more ideal existence than to contain a sufficient number of vegetable cells, constantly removing its waste products, supplying it with starch and oxygen, and being digestible after death. . . . In short, we have here economic inter-relations of the animal and the vegetable world reduced to the simplest and closest conceivable form."

That this is no mere case of parasitism is further proved by the fact that it is exactly those animals containing the algæ ("animal lichens," as the author suggests they might not unfairly be called) which show exceptional success in the struggle for existence, instead of the weakened state to be found in the host of a parasite. They are not only far more abundant, but are capable of enduring greater hardships than their less fortunate allies.

Mr. G. Murray * considers that "to botanists these investigations bear a very peculiar interest. No nearer analogue to this 'consortism,' if it may be called so, of the animal and the vegetable (algal) cell can be found than in that of the fungal and algal cells of the lichens. It is so apparent throughout that it is needless to enter into a detailed comparison. One point in the analogy, however, is noteworthy. The young gonophores of *Velella* which bud off from the parent colony, start in life with a provision of *Philozoon*. One cannot but be forcibly reminded by this of the function of the hymenial-gonidia of such lichens as *Dermatocarpon*, *Polyblastia*, &c., as described by Professor Stahl. The hymenial-gonidia, which are the offspring of the thallus-gonidia, are carried up in the formation of the apothecia, and are cast out along with the spores. Falling in the same neighbourhood, the spores, on germinating, enclose with their filaments the hymenial-gonidia, which ultimately become the thallus-gonidia of the new lichen. The fact that among these animals the most closely allied to each other morphologically differ thus widely physiologically, bears

* 'Academy,' No. 508 (1882) p. 67.

comparison with the near relations of the fungal parts of the lichens with the other ascomycetous fungi."

Cooke's British Fresh-water Algæ.—The existing books on British fresh-water Algæ are so much out of date that a new one will be very welcome to algologists and microscopists. The first part of Dr. M. C. Cooke's work is now published, and contains the Palmellaceæ with 11 coloured plates and 32 pages of text, and is intended to be followed by part 2, the Protococcaceæ and Volvocineæ, and part 3, the Zygnemaceæ. The Desmidieæ and Diatomaceæ are not intended to be included.

Diatoms in thin Rock Sections.—At p. 507 of Vol. I. (1881) we gave an account of a careful study of diatoms from the tolerably hard diatom-rock of Nykjöbing in Jutland, made by W. Prinz from transverse sections of three species:—*Coscinodiscus oculus-iridis, C. excentricus,* and *Trinacria regina.* In the first two instances he obtained exceedingly good demonstrations of the encasing of one valve in the other, as also of the various thickness of the valves at different places. In *C. oculus-iridis* he found the hexagonal honey-comb-like meshes to have an opening at the base, the inner cell-layer having a circular perforation in the middle of each cell. In *Trinacria regina* he found the small round dots which cover the entire valve to correspond to canals which completely perforate the thickness of the valve. Whether this is so also in *C. excentricus* could not be determined with certainty, in consequence of the minuteness of the dots.

Prinz's observations differ from those of Flügel, O. Müller, and Green to this extent, that these latter did not observe an actual perforation of the inner layer of the valve, by which the cell-contents might altogether pass out. O. Müller's observations on *Triceratium Favus* were founded on an ingenious method of flooding. In this species and its allies, including *Biddulphia reticulata,* the inner layer of the valve is completely covered by radial rows of fine dots, which are nowhere wanting, and which exclude the presence of larger openings.

It might be assumed that these small dots correspond to canals which perforate the inner layer; but A. Grunow states* that he has examined very large specimens of the variety *sexangularis* of this species, in which this layer was so thick that it was possible, by focussing, to detect the radiating dots on the inner side, and on the outer side irregularly disposed short spines at the base of the honey-comb-like cells, the walls of which were thickened above and sometimes elongated into a spine at the corners. Similar structures occur in *Triceratium Favus* and in *Coscinodiscus,* while *T. consimile* Green, which closely resembles the former, has exactly the structure of *C. oculus-iridis.* In the last-named species a circular depression is found in the inner layer of the valve, but no perforation. At these depressions the valve is very thin, so that it may be completely broken through there by boiling or in other ways. But an "incontrovertible proof" that there is no actual perforation is afforded by the closely allied species *C. Asteromphalus,* connected with it by inter-

* Bot. Centralbl., viii. (1881) p. 354.

mediate forms. The inner side of the valve is here covered with small dots or depressions, which form a circle of larger dots at the margin of the meshes, gradually diminishing in size and becoming scarcely visible towards the interior, but always covering the whole of the base of the meshes. On closer focussing, these minute dots disappear, and appear to be the depressions taken by Prinz for perforations. In *C. gigas* there are found also in the middle only small round depressions which are surrounded towards the margin by a network projecting outwards, so that this species has internally the structure of the punctured forms, externally that of *C. oculus-iridis*, *radiatus*, and similar species. In *Trinacria regina* the depressions always penetrate very deep, as is the case in many diatoms; but at the base of the depressions is a smaller indentation which, when highly magnified, is very clearly seen in the middle of the pore, as occurs again in many diatoms. Grunow has examined a large specimen of this species, in which a further much more delicate and narrower punctation was visible, apparently on the inner surface of the valves. The transverse section which Prinz draws of *C. excentricus* (or more probably of *C. symbolophora*) appears, however, to be correct; and the pore canals are here mostly represented as not completely reaching the inner surface of the valve. If these depressions permit endosmose through them, their thin inner wall can be perforated only by canals so delicate that they are invisible to the highest powers. Grunow promises a treatise on this difficult subject.

Fineness of Striation as a Specific Character of Diatoms.*— Prof. H. L. Smith comments upon the paper of Count Castracane on this subject,† in which, it will be remembered, he arrived at the conclusion that "the striæ and their fineness *are a quality of specific importance.*"

Prof. Smith says:—"In a few words appended to the translation of the paper, Mr. Kitton, the well-known English diatomist, criticises Count Castracane's conclusions, and indicates the mistakes of the Count himself in his attempt to make these measurements, which he deems of specific performance. The conclusion of the Count, however, will be heartily welcomed by 'species-mongers,' inasmuch as one need have little fear in being able to sustain the claim to *n. sp.* if allowed to fall back on striation as the test, for who shall decide? Not every one has at command the elaborate apparatus used by Count Castracane for determining the number of striæ. Photographs of each diatom, projections on a large scale, &c., seem to be considered by him as the only trustworthy method; a method of such exactness that it 'enables him to disagree with microscopists of incontestable authority.' For Count Castracane personally, and as a correspondent and a thoroughly conscientious, hard-working diatom student, I have the highest respect, but I am sorry that he has felt himself obliged to adopt so pernicious a view, as it seems to me. The Diatomaceæ belong to the vegetable world, and the principles governing

* Amer. Mon. Micr. Journ., ii. (1881) pp. 221-3.
† See this Journal, i. (1881) p. 787.

their classification and arrangement need not be very different from those accepted for other portions of the vegetable kingdom. It would seem that with as much propriety one might consider the number of granules on a *Staurastrum*, or striæ on the frond of a *Closterium*, of specific importance; or the number of fibres in a given space of a specimen of pine or oak, of value in determination of species. I venture the assertion, that if one were to show to the distinguished microscopist who has advocated this view of the importance of fineness of striation, a slide of diatoms, and request him to say what they were, he would name them all, correctly too, and never once resort to measurement of striation to do so. Now, if this can be done, and it is done every day by experienced microscopists, what is the necessity of bringing in an element which most students of the Diatomaceæ consider very variable and exceedingly difficult to determine. I would not have it understood, by what I have said, that I consider striation as of no importance; in conjunction with other things, it has a certain value, but at best only secondary.

"I do not suppose that Count Castracane would for a moment assert that *Stauroneis Phœnicenteron*, e.g., has the same number of striæ in ·001 of an inch as *Stauroneis gracilis*, and yet I have frequently found the latter conjugating, and the sporangial frustule is *S. Phœnicenteron*. The sporangial frustules of the diatoms are notoriously more coarsely marked than the parent frustules. There are a great many species of diatoms, belonging to the *N. prima* group, which really pass into each other so gradually that, even by the help of striation, it is difficult to distinguish them; *N. affinis* produces, by conjugation, true *N. prima*, and I have even observed the large frustules of the latter again producing monsters, by conjugation, far more coarsely marked than the parent frustules. Shall we consider the sporangial form as one species, and the parent form another?

"I have before me now a slide of *Gomphonema olivaceum* containing myriads of frustules, many conjugating, and some with the parent frustules yet adhering to the sporangium. The comparative striation, as measured with a Powell and Lealand spider-line micrometer, is very nearly as 4 to 6, and as the individual measurements of the parent frustules give for the striation 28 to 30 in ·001 inch, we have for the sporangial ones say about 20 in ·001 inch. In this gathering there are numerous free sporangial frustules wholly formed, and quite as coarsely marked, and apparently numerous others of intermediate size and striation. Of what value would striation be here? What I have said about *G. olivaceum* is equally true of other diatoms, notably of the genus *Cymbella*. And yet in conjunction with other characters the striation should not be ignored. In the same gathering, on *Isthmia enervis*, the striation may be so nearly the same on larger and smaller frustules as to appear to be of specific value; but it by no means follows that it will be the same in this species from a widely different locality, nor does my experience with Eulenstein's preparations of *Isthmia enervis* coincide with that of Count Castracane. I find that the small granules on the connecting zone, or central portion, say in ·001 inch, in the ratio of about 5 to 7, measuring, however, not with extreme accuracy, yet sufficiently accurately to show quite a latitude in this respect. Taking a pretty sure gathering, made at the time of the year somewhat remote from the time of the conjugation, I am quite prepared to admit that a preparation of the so-called *Frustulia saxonica*, for example, will not show any appreciable difference in the striation of the frustules; but I would be quite unwilling to admit that this diatom could not be obtained from another locality considerably more finely or more coarsely marked; indeed, Count Castracane himself admits a difference, though he says it has never, to his knowledge, exceeded $\frac{1}{5}$, which, as Mr. Kitton shows, gives a range in *N. crassinervis*, if he understands aright, of 27 to 35 in ·001 inch!

"The general character of the striation, parallel, radiate, &c., the character of the median line, if present, the comparative fineness or coarseness of the striæ—all these are, no doubt, important, as is also, within limited range, the number of striæ in ·001 of an inch. Any one looking over Mr. Habirshaw's 'Catalogue of the Diatomaceæ' will realize what a frightful increase of species was made by Ehrenberg and the earlier observers, from considering the number of rays in the genus *Actinocyclus* as of specific value; equally pernicious is the custom too largely indulged in at the present day by many hard-working Continental observers, who, looking from the standpoint which Count Castracane appears to advocate, find at stated intervals new species, founded upon little else than finer or coarser striation, or perhaps somewhat different outline. It is, no doubt, quite a comfortable way of working, and of keeping one's name before the public, when one finds what is supposed to be a new diatom, if only knowing enough to distinguish the genus, one measures, more or less correctly, the length, breadth, or diameter, and the number of striæ in ·001 of an inch, giving sometimes a representation, which if it be one of the smaller *Naviculæ*, may too often equally well represent many other forms, and, finally, to coin some unpronounceable word, or immortalize some friend, and send forth the bantling; since nobody can venture to question its legitimacy, for does it not differ somewhat from every form hitherto figured or described in outline? And has it not a few more or less striæ in ·001 of an inch? I shall be sorry if, in what I have said, I am considered as censuring men who are unquestionably hard-working and conscientious students of these interesting little organisms. I am only regretting that, instead of labouring to reduce the genera and species of the Diatomaceæ, and seeking for broader and firmer principles to guide in their study and classification, so many worthy persons are contented to accept trivial distinctions as of generic and specific value, and they are so encumbering the subject, that some day it will be crushed by its own dead weight, giving place to a new structure, utilizing as far as possible the ruins, but erected upon a more solid foundation."

Schmidt's Atlas of the Diatomaceæ.*—The recently published parts of this work treat of the following genera:—*Coscinodiscus*,

* A. Schmidt, 'Atlas der Diatomaceenkunde,' Heft 17 u. 18 (8 pls.) Aschersleben, 1881.

Craspedodiscus, *Auliscus*, *Pseudoauliscus*, *Arachnoidiscus*, *Naviculæ* belonging to the groups Didymæ and Lyræ, *Cymbella*, &c.

In *Gomphonema Mustela*, the author states that the frustules, after they have become reduced, by repeated division, to the smallest dimensions, leave their pedicel and attach themselves together, in a reverse position with respect to one another, by their ventral sides; from which he deduces an argument in favour of the animal nature of diatoms.

In the Cymbelleæ, in which the reproduction of *Cymbella gastroides* and *Cocconema Cistula* is delineated, the author believes that there is also, as in *Gomphonema*, a distinction between the upper and under part of the frustule; and supposes that, when conjugating, they also attach themselves to one another in a reverse position. The unsymmetrical arrangement of the cell-contents of several species of *Navicula*, already pointed out by Pfitzer, is illustrated by drawings of *N. dicephala;* and the inference is drawn that all species of *Navicula* present a difference between the anterior and posterior ends, which is well exhibited in some true *Naviculæ.* The very variable cell-contents of *Cocconema lanceolatum* and *Cymbella gastroides* are well illustrated. In *Encyonema gracile*, the author has detected and drawn some very peculiar moniliform corpuscles (possibly parasites) with a trembling motion in the middle of the frustules.

"Aphaneri"—Examination of Water.*—The water of the Lago Maggiore, which it has been proposed to convey to Milan, has lately been examined by Prof. Maggi by M. Certes' method,† the samples being taken at 65 m. depth, and about 400 m. from the banks. Forty-eight hours after a little osmic acid was added, there was obtained a small deposit of dead organisms of bacterian form, none of which had appeared in the Microscope. He found a solution of chloride of palladium to have also the effect of hardening these small organisms and so making them opaque and microscopically visible. Small irregular masses of protoplasmic nature, capable of taking colour from a magenta solution, were also thrown down. Prof. Maggi further treated the water of the lake with various colouring agents. Hæmatoxylin, methyl-violet, magenta, and Lione blue, gave the best results. While the same small organisms and protoplasmic masses were manifested, only the latter, curiously, took the colour. In spring water of Valcuvia, and rain-water, microbes like those in the lake, not visible with a power of 800 diameters, were revealed by the colouring and hardening reagents.

Prof. Maggi proposes to call these organisms *Aphaneri*, as distinguished from the bacteria and microbes which, without reagents, are visible in the Microscope (*Phaneri*), and among which are agents of infection, and which take colour from methyl-violet, magenta, &c. The Aphaneri, he thinks, are probably harmless.

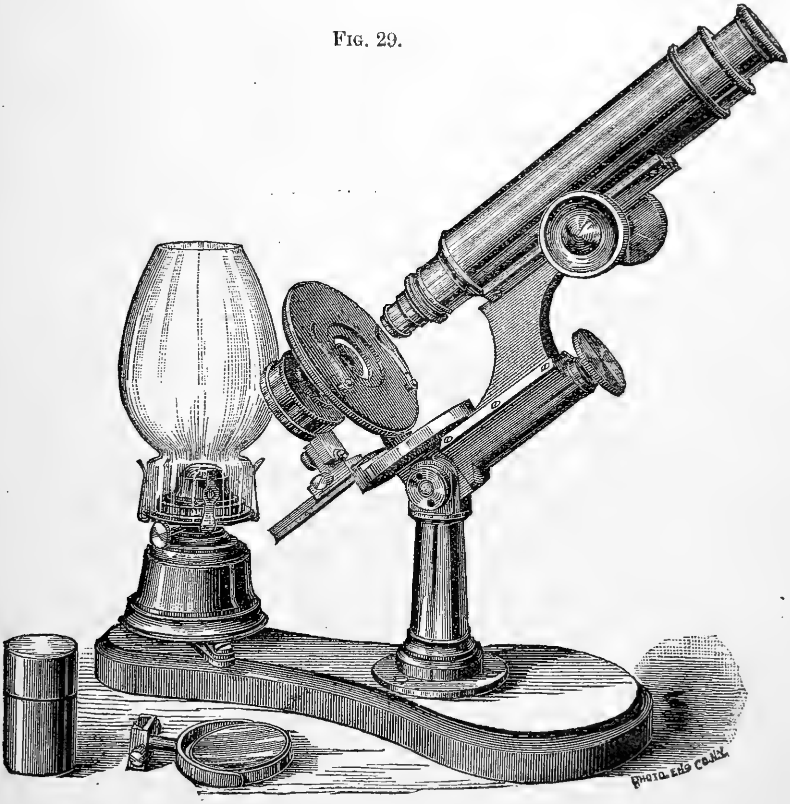
* Nature, xxv. (1882) p. 348.
† See this Journal, iii. (1880) p. 847.

MICROSCOPY.

a. Instruments, Accessories, &c.

"Acme" Class Microscope.—The "Acme" Microscope of Messrs. Sidle and Co. (described in Vol. III. (1880) p. 523) is now adapted for being readily converted into a Class Microscope (Fig. 29). This

Fig. 29.

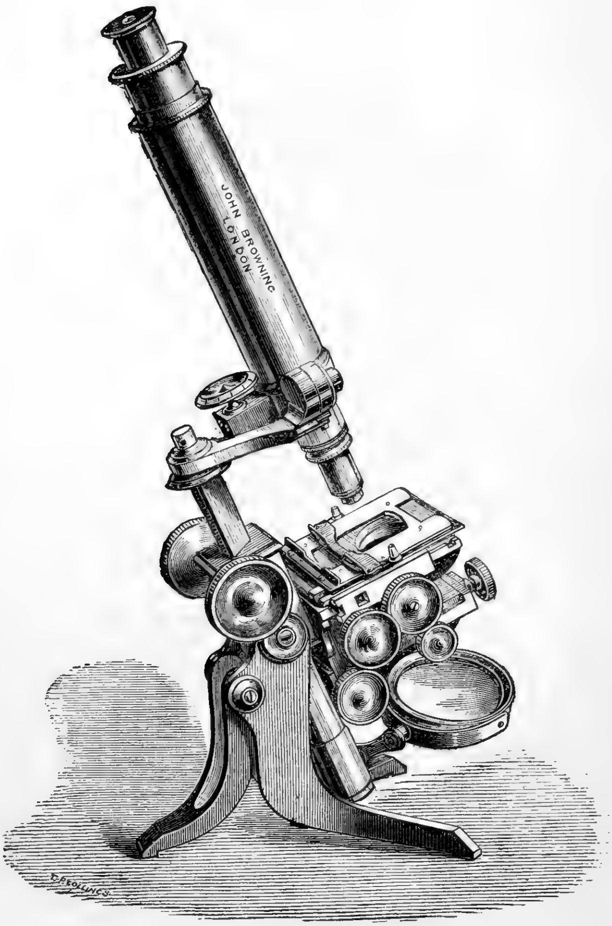


is accomplished by removing the metal tripod foot, and substituting for it a wooden base of suitable form, carrying upon a jointed arm a small lamp. It can then be handed round the class or lecture-room.

We think the ready conversion of ordinary students' stands into class Microscopes, is a point deserving the attention of opticians.

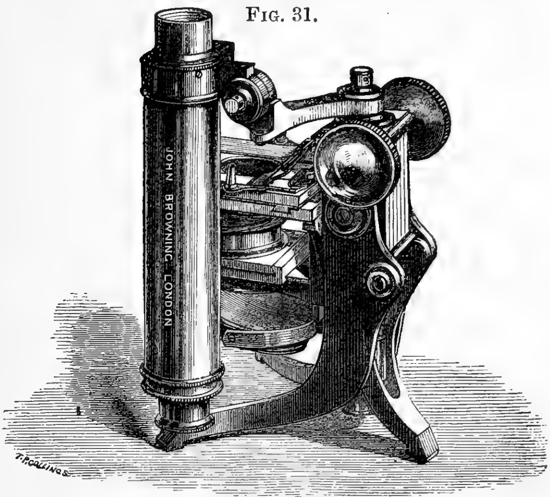
Browning's Portable Microscope.—This Microscope as set up for use is shown in Fig. 30. The stage has the usual rectangular motions, and there is also a substage. The speciality of the instru-

Fig. 30.



ment is that the body-tube turns on a joint as shown in Fig. 31, and that the posterior foot *b* of the tripod can be closed up between the anterior ones. The whole instrument will then pack into a case 6 × 6 × 9 inches.

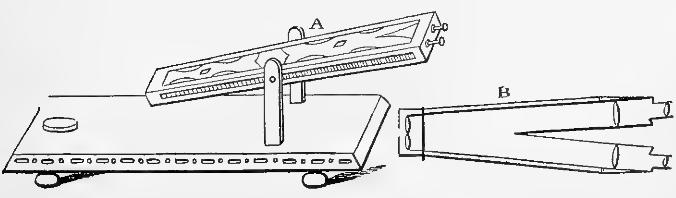
FIG. 31.



Harting's Binocular Microscope. — Professor P. Harting has suggested * a mode of making a binocular Microscope which has not hitherto been described.

The earliest binocular Microscope was that of Cherubin, 1678,† who simply combined two complete Microscopes in one frame (Fig. 32 ‡). Such a device could obviously only be made available with the lower

FIG. 32.



powers; with high powers the necessary proximity of the object would prevent the possibility of any joint convergence of the two objectives.

To obviate this difficulty Professor Harting placed two identical lenses side by side (A and B, Fig. 33) with their axes at an angle *m o n* with one another. If the object *a b* is at a distance equal to twice their focal length, two images of it will then be formed *a' b'*

* Das Mikroskop, 1859, p. 180.

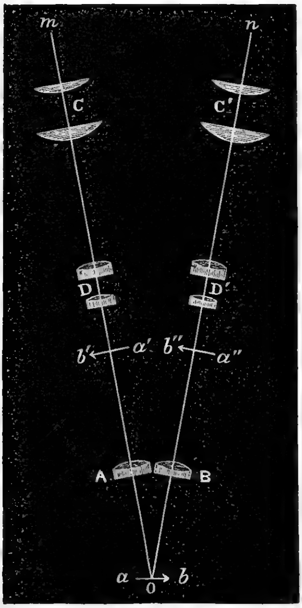
† 'De visione perfecta, sive de amborum visionis axium concursu in eodem objecti puncto.' Paris, 1678, pp. 77–100.

‡ This figure has been correctly copied by the engraver, but the eye-pieces in A would appear to be too narrow.

and $a'' b''$, each of which will be of the same size as the object. Two compound Microscopes with eye-pieces C and C′, and objectives D and D′, are then used to examine the two images.

Professor Harting writing in 1858 said "were the images $a' b'$ and $a'' b''$ so clear and sharp that they might be assumed to represent the object itself, objectives of short focal length might be used. But we are yet far from having the objects so represented by our present lenses. Even if the images are formed by objectives of fairly low power—1 to 2 cm.—the difference between the images and the

FIG. 33.



object is still too great, as was found as the result of some experiments made for the purpose. This contrivance cannot therefore be applied successfully to the construction of binocular Microscopes, which is the more to be regretted as this arrangement seems to satisfy better than any other the requirements of true stereoscopic vision. Perhaps future improvements in the construction of objectives will more readily allow of the accomplishment of the desired aim."

As this was written nearly thirty years ago, it is very probable that the defects in the objectives which were then found to mar the action of the suggested instrument would not now be met with, but we doubt nevertheless if it would be found at all worth while to construct such an instrument. Any improvement in the stereoscopic effect over that furnished by some of the modern binoculars would be likely to be more than balanced by the additional complication of the instrument.

Nachet's Double-bodied Microscope-tube.*—An ordinary Microscope can be readily converted into one for two observers by the plan shown in Figs. 34 and 35. A nose-piece screws into the end of the

FIG. 34.

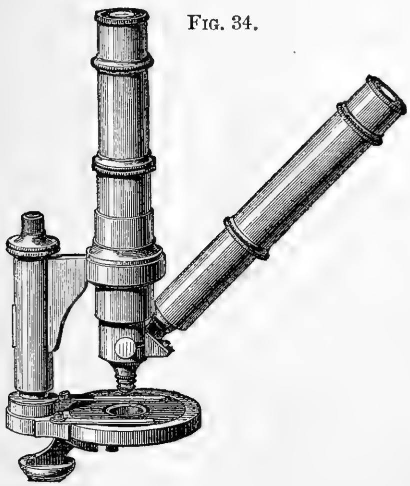
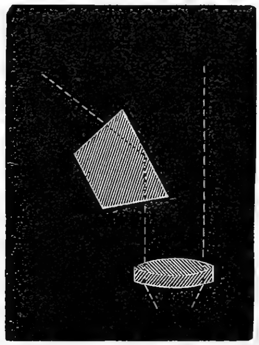


FIG. 35.



body-tube, carrying just above the objective a truncated prism, which bisects the pencil from the objective, allowing half to pass direct to the eye-piece, while the other is diverted by the prism into a second tube screwing into the nose-piece and set obliquely. Powers of 200 to 300 times can be used.

Wenham's Universal Inclining and Rotating Microscope.—This new Microscope (Plate IV.) has been devised by Mr. Wenham for the special purpose of obtaining a large range of effects of oblique light both in altitude and azimuth.

The principal movements are as follows: (1) an inclination of the limb together with the body-tube, stage, substage, and mirror, in a sector sliding within jaws attached to the rotating base-plate. The centre of this inclining motion is (very approximately) the point where the plane of the object cuts the optic axis, i. e. a point situated about the thickness of an ordinary object-slide above the centre of the surface of the stage; (2) a lateral inclination of the limb to either side upon an axis attached to the centre of the sector. The centre line of this axis prolonged forwards also intersects the optic axis in the plane of the object on the stage; (3) a rotation of

* See Robin, C., 'Traité du Microscope,' &c., 1877, pp. 72–3 (2 figs.).

the instrument upon its circular base, the optic axis being the centre of motion.

The leading principle followed in the construction of the stand is

Fig. 36.

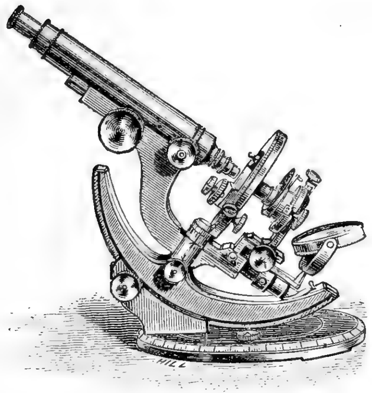
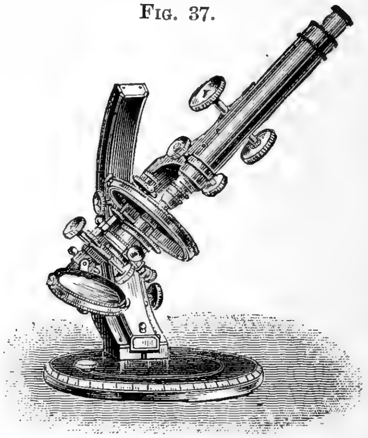


Fig. 37.



that when it is inclined backwards (as in Fig. 36), or turned laterally (as in Figs. 37, 38, and 39), or rotated on the base-plate, a pencil of

Fig. 38.

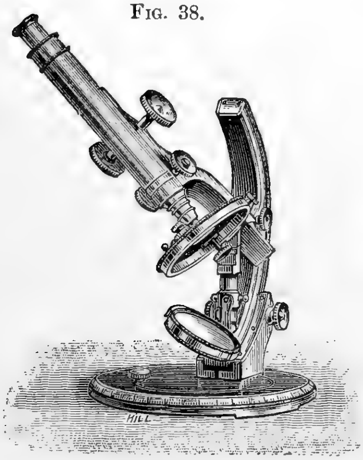
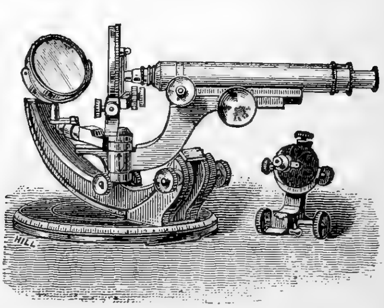


Fig. 39.



light from a fixed source will always reach the object, all the movements, whether separate or combined, radiating from the object (or the prolongation of its axes) as a centre.

The stage rotates completely and is a modification of Mr. Tolles's, in which the rectangular motions are effected by milled heads acting on the surface and entirely within the circumference.* It is mounted on the Zentmayer system, and graduated near the edge, "finders" being engraved in convenient positions; two centering screws are provided by which exact rotation round the optic axis can be secured; and it can be easily removed, or may be replaced by a glass or metal friction-stage, &c. A simple and effective plan has been adopted of applying the iris-diaphragm, hemispherical immersion illuminator, or Wenham's "half-disk" illuminator, beneath the stage, where they are held by a small projecting peg and a spring latchet.

The substage can be removed entirely from the lower part of the limb by means of a metal dove-tail slide The usual rectangular (centering) and rotating motions are provided.

The substage condenser is furnished with a centering cap and a rotating plate of the usual series of slots, central stops, &c., an iris-diaphragm immediately beneath modifies the diameter of the circular opening utilized.

The coarse adjustment is of the usual "Jackson" form by means of a spiral pinion and diagonal rack-work.

The fine adjustment acts directly upon a vertical slide carrying the objective only, and is controlled by vertical milled heads on both sides of the nose-piece.

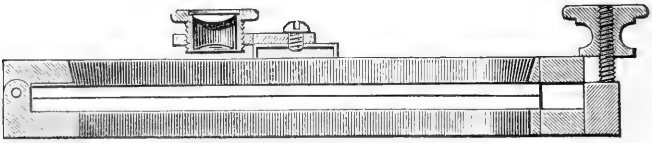
In illustration of the variety of motions obtained with this Microscope, Fig. 36 shows the sector inclined at about the usual position for working with central illumination; Fig. 37 shows the lateral inclination of the limb, &c., the sector being at its highest position; Fig. 38 shows the Zentmayer swinging tail-piece clamped to the sector (as suggested by Mr. J. Mayall, jun.), the limb being inclined laterally, and the substage removed. This lateral inclination of the limb causes the stage to revolve upon a central horizontal axis, so as to present the object to the illuminating pencil at all obliquities; Fig. 39 shows the sector at the lowest point so that the microscope-body is horizontal, the tail-piece being clamped to the sector, the limb swung laterally about 45° (to the right), and the substage removed. This position of the sector would be that required for measuring angles of aperture by means of the graduations on the circular base. The axis of the lateral inclining motion is also graduated, so that either the degree of inclination of the limb or that of the swinging tail-piece can be registered. In all these positions, and indeed in every position in which the various movements enable it to be placed, the Microscope is very steady.

The construction of the stand has been carried out by Messrs. Ross under Mr. Wenham's instructions, and we understand that they purpose making such modifications as will permit a lamp to be carried by the swinging tail-piece, or placed at the lower end of the sector; and the mirror to be attached at pleasure to a rotating slide in the centre of the base: these additions will add still more to the facilities for obtaining obliquely incident light.

* See the descriptions of similar stages, this Journal, i. (1881) pp. 116–117 (Figs. 9 and 10), p. 300 (Fig. 46), and pp. 944–6 (Figs. 221–3).

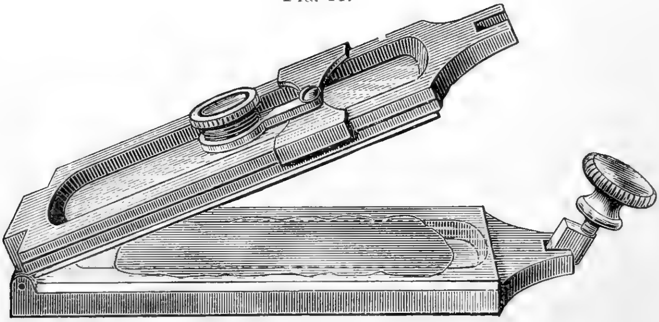
Bausch and Lomb Optical Co.'s Trichinoscope.*—Figs. 40 and 41 show the Trichinoscope recently issued by the Bausch and Lomb Optical Co. It consists of two metal plates, each pierced with a central hole and hinged together at one end, and so arranged that they can be forced together by the screw at the opposite end. Two glass plates

FIG. 40.



are inserted between them. A simple Microscope can be moved in different directions across the apertures in the plates so as to command a view of every part. It is focussed by being screwed up and down in the socket at the end of the arm which carries it.

FIG. 41.



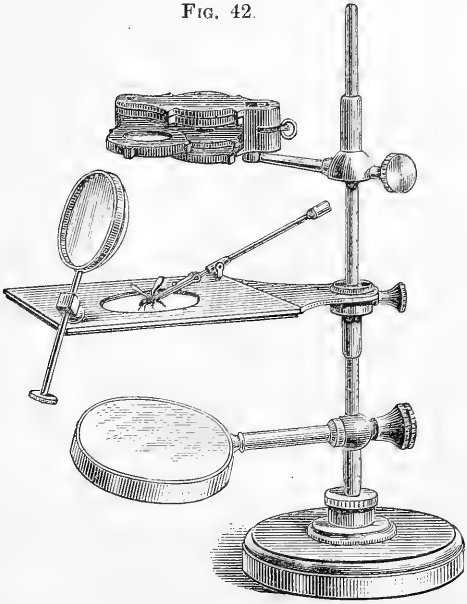
A thin slice of flesh having been moistened with a mixture of equal parts of acetic acid and glycerine, is put on the lower glass plate and spread out by needles or a brush, the second plate is brought down upon the lower one and the screw is placed in the slot into which it fits. By turning the screw any degree of pressure may be brought to bear on the flesh, which may thus be rendered so thin and transparent that any trichinæ present will be readily visible when the Trichinoscope is held up between the eye and light.

"Hampden" Portable Simple Microscope.—This instrument (Figs. 42 and 43) is made by Messrs. Beck and is the device of the wife of a distinguished English statesman now ruling in India. It combines, with great portability, very convenient arrangements for the

* Amer. Jour. Micr., vi. (1881) pp. 183-5 (3 figs.).

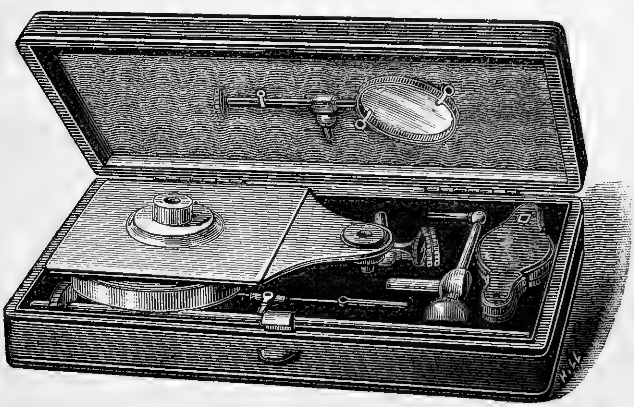
most effective use of a dissecting lens or simple Microscope in the field or when travelling.

Fig. 42.



The lens, stage, and mirror are each carried by a bar sliding on the upright stem which screws into the circular foot. The bars can be

Fig. 43.



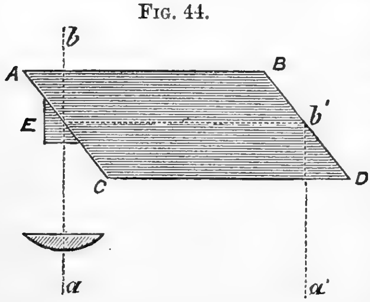
adjusted to any height and secured by the screws, of which the milled heads are shown on the right of Fig. 42. When detached the instrument packs very conveniently into a small case $5\frac{1}{2}$ in. × $2\frac{3}{4}$ in. × $1\frac{1}{4}$ in. in the manner shown in Fig. 43, and is then readily carried in the pocket.

Sir John Lubbock, who has on several botanical excursions taken the instrument with him, speaks highly of its usefulness.

Excluding Extraneous Light from the Microscope.*—In order to exclude light of an injurious character, whether falling laterally on the eye of the observer or on the stage from above, T. W. Engelmann places the Microscope in a dark box, made portable, and admitting the light through a funnel-shaped opening in the broad front side. The body of the observer as well as the Microscope and its belongings are intended to be included in the box, which is 75 cm. high, 80 cm. broad, and 40 cm. deep, and is arranged so as to carry accessory apparatus, reagents, coloured glass plates, &c.

Nachet's Improved Camera Lucida.—In its original form this camera lucida consisted of a rhomboidal prism A B C D, placed over the eye-piece of the Microscope, as shown in Fig. 44, and having cemented to the face A C a segment of a small glass cylinder E, the ray *a b* from the eye-piece and that (*a′ b′*) from the pencil meeting the eye at *b*.

Fig. 44.



The disadvantage of this form was that the eye must be held very steadily just over the glass cylinder E (the function of which was to allow the rays from the object to pass to the eye-piece without refraction), to obviate which M. Nachet has made use of a suggestion of Professor G. Govi, and deposits a thin film of gold on the face A C of the prism (Fig. 45). The gold reflects the ray *a′ b′* to *b* as

Fig. 45.

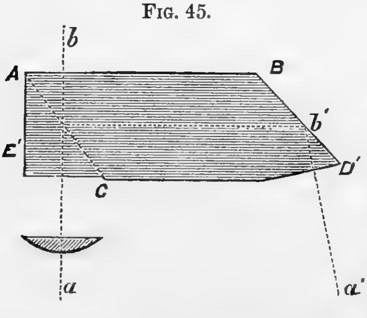
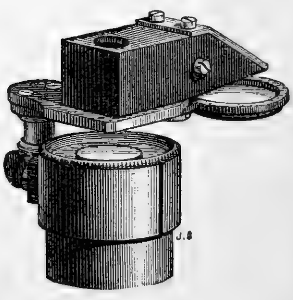


Fig. 46.



before; whilst, at the same time, on account of its translucency, it allows the ray *a* to pass through it from the eye-piece. The small

* Pflüger's Archiv ges. Physiol., xxiii. (1880) p. 571.

prism E is replaced by a larger one, E′, cemented upon the gold film (protecting it also from being rubbed off), and a slight inclination is given to the under surface at D′, in order to avoid too great an approximation of the pencil to the foot of the Microscope.

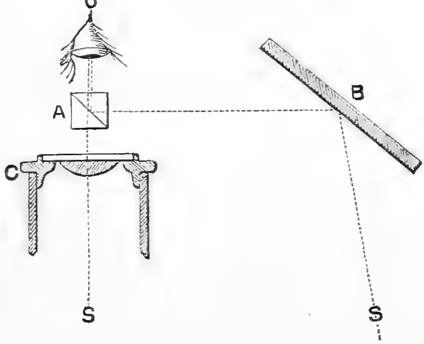
The image of the paper is tinted yellow by the rays reflected from the surface of the gold, while that of the object is of an emerald green tint, that being the colour given to the rays in passing through gold.

Fig. 46 shows the camera lucida in place over the eye-piece.

Abbe's Camera Lucida.*—Dr. L. Dippel commends the following as an extremely simple and complete apparatus for drawing on a horizontal surface.

A small glass cube A (Fig. 47) composed of two right-angled prisms cemented together is placed over the eye-piece C, one of the prisms having an hypothenuse surface silvered, leaving, however, a

Fig. 47.



circular hole. The cube is so adjusted that the hole exactly coincides with the "eye-point" of a Zeiss No. 2 ocular (C). The mirror B is connected with the fastening of A by an arm about 70 mm. from the axis of the Microscope.

In use, the instrument is fastened to the eye-piece cover by two centering screws, and the mirror so turned that the surface of the table close beside the foot of the Microscope appears to be projected on the circular field of the eye-piece. The whole field of view is now readily seen, and with uniform sharpness, and this is the case also when the higher powers are used, no perceptible loss of light taking place in the vision of the microscopical image. One of the most essential qualities of a good camera lucida is therefore obtained.

That the camera is attached to a particular eye-piece, and is not, as usual, made adjustable for those of different power, arises from the fact that in the higher Huyghenian eye-pieces the eye-point lies too near the eye-lens.

* Bot. Centralbl., ix. (1882) pp. 242–3 (1 fig.).

Dr. Dippel says that he has thoroughly tested the camera with very delicate drawings, and has found it of excellent service, and he considers it is to be preferred over all those forms for drawing on a horizontal surface in which the microscopical image is seen after several reflections, and the pencil direct.

Curtis's Camera Lucida Drawing Arrangement.*—Mr. Bulloch's new "Congress" stand has an arrangement for drawing, suggested by Dr. L. Curtis, "which is designed to do away with some of the difficulties attending the use of the ordinary camera lucida. A little table is fastened to the limb by milled-head screws; paper is placed upon this for drawing. One of Hartnack's right-angled camera lucidas is used. Drawing can be done in any position of the Microscope. There is hardly more preparation required for this than would be required to change an eye-piece. The comfort of this arrangement, when one is doing work which requires much drawing while observation is going on, needs to be experienced to be appreciated."

Drawing on Gelatine with the Camera Lucida.†—M. Créteur uses a metallic point for drawing objects with a camera lucida, the drawing being made not on paper, but on a sheet of gelatine laid on a dark ground. The shining point is always visible, and is claimed to provide a remedy for the indistinctness of the point of the pencil, which is the chief difficulty experienced in drawing with the camera by the ordinary method. The drawing can also be readily transferred to stone.

It is questionable whether the advantage gained through the greater distinctness of the drawing-point is not more than counterbalanced by the disadvantage of not being able to draw on paper. As the particular benefit claimed appears to rest upon the shining point, that could be obtained without great difficulty with an ordinary pencil.

Iris-Diaphragm for varying the Aperture of Objectives.—In 1869, Dr. Royston-Pigott applied an Iris-diaphragm behind the objective for reducing the aperture of objectives, in support of the view which he was then advocating that wide-aperture objectives produced confused images.

The editor of the 'Northern Microscopist' has recently suggested the use of such a diaphragm to enable penetration to be obtained with wide-angled objectives of different apertures. Fig. 48 is a side view of the apparatus, as made by Mr. C. Collins, and Fig. 49 a front view. The upper end in the former figure screws into the microscope-tube, while the lower receives the objective. The diaphragm is opened or shut by sliding the lever projecting at the side. The partial closing of the diaphragm does not, of course, contract the *field*, but diminishes its brightness by obstructing the passage of a greater or less part of the cone of rays.

* Amer. Mon. Micr. Journ., iii. (1882) p. 13.
† Bull. Acad. R. Méd. Belg., 1880, p. 617.

In some remarks on the use of the apparatus it is pointed out * that it shows the value of wide apertures for good definition, for if a preparation of the proboscis of the blow-fly be observed with an inch objective having an air angle of 30°, the view is superb, the pseudo-tracheal markings come out well-defined and sharp; but close the shutter until an angle of 14° or less is obtained, and examine again,

Fig. 48.

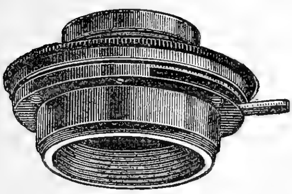
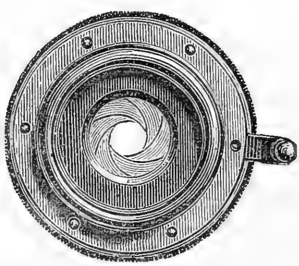


Fig. 49.



when it will be found that the definition is not nearly so good, while there is more penetration, the whole of the pseudo-tracheal tube being observed under one focussing. While in this condition, the eye being still applied to the tube, open the shutter to its full extent, and the effect of wide aperture will demonstrate itself.

"Perhaps the best object to show the amount of penetration possessed by objectives of low angle, may be found in the micro-fungus, *Myxotrichum deflexum*, or *M. chartarum*, observed under the 1-inch objective. The former object consists of little patches of grey downy balls, from which arise a number of radiating threads, furnished with a few opposite and deflexed branches. Under an inch objective of 30° air angle, but few of these branches can be seen under one focussing, the remainder being enveloped in a haze of light; but if a central layer be focussed, the simple closing of the shutter will suffice to bring the superior and inferior layers into view, though, of course, the image is not so bright and well defined as before."

Gundlach ½-inch Objective †—Dr. L. Curtis recently exhibited to the State Microscopical Society of Illinois a new ½-inch objective made by Gundlach, and claimed by the maker to have an angle of 100°. The back lens is large, and extends beyond the border of the opening in the screw. This opening, therefore, acts as a diaphragm. In order to secure the benefit of the full aperture, the portion of the objective can be removed, and an adapter furnished with the Butterfield broad gauge screw can be substituted. It has also another screw of about the same diameter as the Butterfield screw, but provided with a finer thread. The name and description of this screw were not known. The front of the objective is ground down to a conical

* North. Microscopist, ii. (1882) pp. 13–14 (2 figs.).
† Science, iii. (1882) pp. 19–20.

shape. For ordinary use this front is covered with a brass cap, having an aperture in the centre to allow the conical end of the objective to pass through. The cap can be removed when it is desired to use the objective for the examination of opaque objects. On removal of the cap the conical sides of the lens are seen to be covered with some sort of black varnish to prevent the passage of outside light. A Lieberkuhn is furnished, which can be screwed on in place of the cap while examining opaque objects.

Scratching the Front Lenses of Homogeneous-immersion Objectives.—It was recently objected to homogeneous-immersion objectives that the necessity of wiping the oil from the front lens after each observation was fatal to their utility as in time the front surface would thus become so scratched as to render the objective unfit for use.

This objection, however, overlooks the fact that even assuming it was really impossible to properly clear off the immersion fluid without "scratching" the lens, such scratches would not interfere with the use of the objectives. As the fluid used for immersion is *homogeneous*, that is, may practically be considered fluid crown glass, the scratches are optically obliterated as soon as they are in contact with the oil or other medium; in fact, it will be seen on reference to the original paper of Mr. Stephenson on homogeneous-immersion objectives,* that one advantage of the system was pointed out to be that in petrographical work the very imperfect polishing of thin sections of minerals, which had previously been a source of difficulty, was overcome by the approximately optical identity of the object and immersion fluid.

Fluids for Homogeneous Immersion.† — Dr. H. van Heurck, Director of the Antwerp Botanical Gardens, has undertaken an extended investigation of fluids suitable for homogeneous immersion, which (1) should have an index of 1·510–1·520 (line F), and (2) a dispersive power of 0·006 (between D and F), (3) should not be too fluid, and (4) should not attack the varnish of the slides.

Amongst the chemical solutions hitherto suggested, Dr. van Heurck mentions Bassett's fluid (which attacks varnish), chloride of cadmium in glycerine, iodide of zinc in glycerine, sulpho-carbolate of zinc in glycerine, and distilled chloride of zinc (difficult to use and not capable of being well preserved). Of the vegetable substances, cedar oil and oil of copaiba are referred to. The first is a product not of the cedar, but of *Juniperus virginiana*, and is much too fluid, and attacks the varnish of the cells. The second (distilled from different species of *Dipterocarpus*) is a little less fluid and therefore better.

To remedy the inconvenience of the extreme fluidity of cedar-oil, dammar has been dissolved in it, by which also its index may be raised to 1·54. Professor Abbe has recently suggested to the author that an excellent fluid may be obtained by dissolving dammar until the index is 1·520, and then reducing it to 1·509 by the addition of castor-oil.

* See this Journal, i. (1878) p. 52.

† Bull. Soc. Belg. Micr., vii. (1881) pp. xxii.–xxxi.

In his examination of new fluids, Dr. van Heurck met with no sufficient success amongst chemical products, but of vegetable substances three were discovered which appear to be in every way suitable.

The first is a solution of the resinous gum known as *oliban* (from several species of *Boswellia* of East Africa) partially dissolved in cedar-oil. It gives a fairly thick lemon-yellow liquid of refractive index 1·510, and dispersive power 0·0077. To prepare the liquid, pieces of very pure oliban are powdered finely, and the powder, mixed with its own volume of cedar-oil, is heated in the water-bath in a glass beaker for 2–3 hours. It is then left till the next day, when the supernatant liquid is drawn off.

The resin (*élemi*) of Brazil, and the white oily *tacamaque* of Guibourt give equally good solutions with oil of cedar. By dissolving the tacamaque in the oil a liquid is obtained with a refractive index of 1·519, and dispersive power of ·0074. By adding castor-oil to the solution in suitable quantity the index is lowered to 1·508, and the dispersive power to 0·0072. To prepare the solution, 20 parts by weight of the tacamaque are dissolved in the water-bath in 22 parts of cedar-oil and 14 parts of castor-oil added.

According to Professor Abbe, the latter solution and that of dammar in cedar-oil constitute the two best fluids for homogeneous-immersion objectives.

The third is copaiba of Maracaibo, derived from *Copaifera officinalis.* That found in commerce at Antwerp, and apparently authentic, had an index of 1·519, whilst a specimen from Guibourt of copaiba of Para was only 1·506. It dissolves readily in cedar-oil. Another liquid of 1·510 index and ·0076 dispersive power is obtained by dissolving 7 parts of light vaseline in 30 parts of copaiba. A very thick liquid results, not attacking varnish even after a contact of 24 hours. If it is found to be too thick it can be diluted by mixing with it a solution of copaiba in cedar-oil.

Other liquids from conifers were tried, but in all the dispersive power was found to be too high.

Dr. van Heurck fears that it will be very difficult to discover any substances which will satisfy microscopists who prefer *aqueous* liquids.

Advantage of Homogeneous Immersion.*—Dr. van Heurck also says that "the suggestion of Mr. Stephenson . . . . constitutes certainly the greatest advance which has been made in microscopy during late years. Personally we have been able to appreciate, better perhaps than any one, the importance of such objectives, for it is owing to them that the thousands of drawings in the 'Synopsis des Diatomées de Belgique' could be furnished in a relatively short time. When we think of the trouble that monochromatic illumination has caused us, and the frequent interruptions necessitated by the absence of the sun, we cannot sufficiently congratulate ourselves upon this fortunate discovery, which has enabled us to advance, by a good many

* Loc. cit., pp. xxii.–iii.

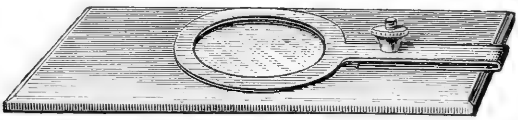
years perhaps, the publication of our work, all the drawings of which have been made or perfected by homogeneous-immersion objectives."

Vertical Illuminator for examining Histological Elements.*—Dr. E. van Ermengem commends the vertical illuminator for the illumination of such of the histological elements as can be mounted on the cover-glass dry. "Blood-corpuscles present an extraordinary appearance, their colour a lively red, their relief very appreciable, and the slightest inequalities on their surface clearly visible." Good results had also been obtained in the examination of semen, mucus, pus, and liquids containing bacteria, &c.; also of the minute structure of muscles and nerve-fibres.

Griffith's Parabolic Reflector.†—Mr. W. H. Tivy describes a method suggested to him by Mr. E. H. Griffith for utilizing a spoon for a "parabolic" reflector. Wind a clean copper wire of $\frac{1}{24}$ inch diameter closely round the base of an objective three times, twisting and bending the ends for a length sufficient to reach a little beyond the end of the objective. Cut a section of about half an inch from the bowl of a new plated teaspoon, and solder the convex side to the ends of the wire, also making the loop solid with solder, and filing it up to a good fit and figure, so that it will slip easily on and off the objective. The reflector is adjusted by bending the wire. "Thus I have a handy and useful piece of apparatus, at the cost of the spoon, 30 cents."

Forrest's Compressorium.—This compressorium (Fig. 50), designed by Mr. H. E. Forrest, is specially constructed with a view to cheapness. It consists of a strong glass (or if desired brass) plate,

Fig. 50.



3 inches by $1\frac{1}{4}$ inches, with ground edges. A small brass screw passes through the plate, the point projecting upwards through it about $\frac{3}{4}$ inch. A brass arm, bent so as to form a spring, rotates upon the screw as on a pivot, and carries at one end a brass ring holding a thin cover-glass, 1 inch in diameter, which covers the centre of the plate when in use. A milled nut works upon the screw above the arm, and when screwed down brings the cover-glass in contact with the glass plate. The spring acts upon and raises the cover, if the nut is unscrewed, so that the two glasses can be fixed at any degree of proximity required.

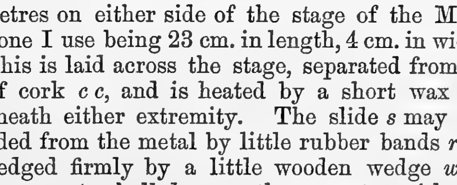
Julien's Stage Heating Apparatus.‡—In a paper on the examination of carbon dioxide in the fluid cavities of topaz, Mr. A. A. Julien thus describes the method employed in his investigations.

* Bull. Soc. Belg. Micr., vii. (1881) pp. xxxvii.–xl.
† Amer. Mon. Micr. Journ., ii. (1881) p. 238.
‡ Journ. Amer. Chem. Soc., iii. (1881) 12 pp. and 4 figs.

"The qualitative identification of carbon dioxide in the cavities of a mounted thin section of a mineral may be determined, at least with probability, after some experience, through various optical appearances and physical characteristics which have been often described. It is usually effected with certainty and ease, through the rapid and enormous expansion and ultimate disappearance, either of the liquid or of the gaseous bubble on the application of a gentle heat for a few seconds, such as that of a cigar, the heated end of a rod, or jet of hot air, or even a jet of the warm breath conveyed through a flexible rubber tube. When the slide and the section are thin, even the heat (37° C.) of the tip of one's finger applied for a few seconds to the bottom of the slide, without removal from the stage of the Microscope, may be sufficient to produce the characteristic phenomena, e. g. the contraction and disappearance of a bubble whose size is relatively small to that of the liquid in which it floats.

For the determination of the temperature of disappearance of the bubble, which may vary from 20° to 32° C., several forms of stage heating apparatus may be employed (those of Nachet, Beale, Fuess, Schultze, Chevalier, Dujardin, Ransom, Polaillon, Ranvier, and Vogelsang). In place of all these, a simple and inexpensive apparatus may be substituted, consisting of a miniature water-bath, in which are immersed the entire section and slide, the bulb of the thermometer, and the nose of the objective. It consists of a box of tinned copper (Fig. 51) (tinned iron is liable to rust), of length sufficient to project

FIG. 51.

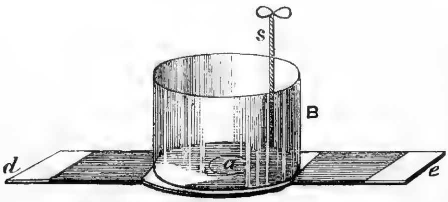


a few centimetres on either side of the stage of the Microscope employed; the one I use being 23 cm. in length, 4 cm. in width, and 3 cm. in depth. This is laid across the stage, separated from the metal by thin plates of cork *c c*, and is heated by a short wax taper (night-light) underneath either extremity. The slide *s* may rest upon the bottom, guarded from the metal by little rubber bands *r r* beneath its ends, and wedged firmly by a little wooden wedge *w* beneath the horizontal thermometer bulb *b*; or a thermometer with a ring-shaped bulb may be inserted, upon which the slide may rest directly, firmly attached by one or two slender rubber bands. The thermometer should be of guaranteed accuracy, with wide degrees, subdivided if possible, with a range which need not much exceed 20° to 32° C. The preparation is then covered by any pure and clear water, preferably filtered (distilled is unnecessary), to a depth of about 2 cm. A circular aperture in the bottom of the box, 18 mm. in diameter, is covered with glass attached by cement, and through this the light is thrown up from the mirror. The cavity to be examined is then carefully adjusted and focussed, a taper is lit, and the eye remains at the eye-piece until the critical point is reached. The glass tube *t*, with its point terminating just below the edge of the slide, is connected with the mouth during the experiment by a small rubber tube. As the temperature slowly rises, a constant current of small bubbles of the warm breath (whose temperature, 32°, only assists the operation) may be blown with little fatigue through the tube, to effect a thorough intermixture of unequally heated layers in the water stratum. The determination of the temperature of disappearance of the bubble is easily obtained within five minutes, and that of its reappearance in about the same time. A low-power objective may be carefully wiped if its anterior lens is dimmed by flying drops or rising vapour, when a high temperature is being attained; but it is best to insert the whole objective in a small, narrow glass beaker floating upon the surface of the bath over the preparation.

The apparatus, as thus constructed, may, the author thinks, be found the most convenient warm stage when high temperatures are required; but another still more simple, lately devised, will best serve for the determination of carbon dioxide, and consists of the following parts:—

First, a shallow glass tank (Fig. 52), with thin and well-annealed sides, of size sufficient to enclose the slide, upon which the thin

FIG. 52.



section is mounted. For this purpose I use a small chemical beaker B, with the thinnest bottom, and with its upper portion cut off, forming a thin round glass tank, about 6 cm. in diameter, and 3 cm. deep.

Secondly, a plate of copper or brass, like that used in Schultze's apparatus, or more simply one of the form represented in the figure *d e*. Its dimensions, proportioned to those of the beaker-tank and of the stage of a large Microscope, are as follows:—Length, 23 cm.; diameter at centre, 6·5 cm.; width of arms, 3·5 cm.; central aperture, 2·5 cm.; height of wire support, 13 cm.; thickness of plate, 1 mm. Each arm is wrapped in pasteboard, to prevent radiation, to the extent indicated by the shaded portion.

Thirdly, a delicate thermometer, with a small, short bulb bent at right angles to the stem, and a very fine column, to obtain sufficient sensitiveness to minute variations of temperature, and complete immersion of the bulb in the small volume of liquid employed in the bath. The scale need not exceed in range from about 20° to 32° C., the thermometer being of such length that when in position the scale from 27° to 30° C. may be on the level of the eye-piece of the Microscope, and readily visible without motion of the head. Each degree of the column should be about a cm. in length, and subdivided to tenths.

Lastly, a pointed glass tube, with flexible rubber connection for blowing, and a wire support *s*, to receive both this and the thermometer, attached to the metal plate.

The latter is laid upon the stage of the Microscope, separated by thin plates of cork or a perforated piece of pasteboard; the tank, supplied with about 40 cc. of water, is placed over the central aperture *a*, and a taper beneath an extremity of one arm of the plate, and the apparatus is then ready for use in the way already described, the water of the tank being heated by conduction through the metal plate. The section of the mineral is best mounted upon a very thin slide, 45 mm. by 26 mm., and this is guarded as before with rubber bands, and held down by one or two little brass weights. Only a single taper is necessary for the low temperature required in the examination of carbon dioxide cavities, and even with this a temperature of 43° C. may be obtained in the bath within a few minutes. The disappearance of the bubble may be completed in less than five minutes, the taper being removed as soon as the rising column approaches within 2 or 3 degrees of the critical point, roughly determined by a previous trial. If two tapers are used, the temperature of the water may be raised to 55° in about 20 minutes, or even much higher, by the use of Bunsen gas burners. In summer the temperature of the atmosphere alone may be sufficient, especially if assisted merely by the current of warm breath, to obliterate the gas bubble. Its return may be readily caused, in a warm atmosphere, by adding from time to time a few drops of cool water to the bath, while the eye remains at the eye-piece, and a steady current of air is blown through the glass tube. Mounted slides used for such experiments must be labelled by writing with a diamond, or the paper label may be rendered waterproof by being coated successively with weak size and any transparent varnish, such as copal or shellac.

From these experiments it may be inferred that with this apparatus, which may be called the immersion warm bath, it matters little for most purposes what liquid, stand, or objective is employed; that water is preferable to glycerine, from its greater mobility, convenience, and lack of cost; that its bulk is immaterial, so long as the bulb of the thermometer is covered; that it is decidedly advantageous to immerse the anterior lens of every objective in the bath, to avoid the annoying interference with observation produced by the vibration of the surface, and by the necessity for repeated refocussing, when the objective is above the surface of the liquid; that careful determination on minute cavities, with high powers, carried on slowly to enable the preparation, objective, and thermometer to assume the same temperature, may be as accurate as any others; and that there is no difficulty in obtaining satisfactorily the two determinations within ten minutes to an approximation of about one-twentieth of a degree.

The descriptions of this method, and of these forms of apparatus, have been given in the more detail, inasmuch as they may be of service in many other branches of thermal microscopy where the exact determination of the temperature applied is desirable, e. g. as suggested by Mr. A. H. Elliott, in the determination of the melting point of rare chemical substances, &c. For this purpose, the apparatus in Fig. 51 might be supplied with another tube, on the opposite side to those represented, through which might be inserted, beneath the objective, a small glass tube containing the substance to be examined, and thus immersed, by the side of the thermometer bulb, in the water, oil, paraffin, or other liquid which the circumstances may require for the bath."

Beck's Achromatic Condenser for Dry and Immersion Objectives.—In an earlier form of (dry) condenser (Fig. 53), Mr. Beck made use of a revolving front rotating a series of lenses mounted on a plane

FIG. 53.

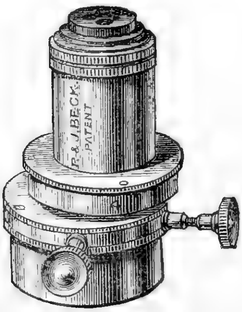
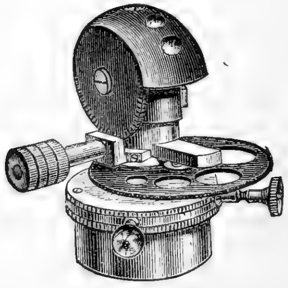


FIG. 54.



surface over the back combination. This plan was, however, only available for a dry condenser; if used for immersion, the connecting fluid would be drawn away by capillary attraction.

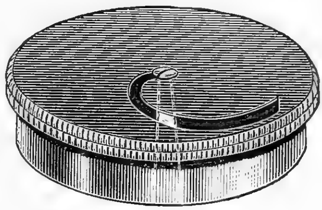
To avoid this inconvenience, the new form shown in Fig. 54 has been devised, the movable series of front lenses being mounted in a segment of a sphere and rotated by a milled head acting on a pinion and toothed disk. The first lens, when brought over the back combination, has a low angle, and is intended for use without fluid for histological objects. By revolving the diaphragm, the angle can be varied from 35° to 7°. The next is a full aperture lens with which, by revolving the diaphragm, the angle can be varied from 180° downwards. The third lens, with full aperture of diaphragm, has an angle of 110° in glass = 1·25 N.A., and is truncated, cutting out the central rays. The fourth lens has also an aperture of 1·25, and is truncated, so as to stop out all rays up to 180° in air. The fifth is similar to No. 3, but the periphery is painted over, so as to allow pencils only at right angles to pass.

Pennock's Oblique Diaphragm.*—Mr. E. Pennock suggests an adaptation of Mr. Mayall's spiral diaphragm,† to be attached to the

* Amer. Journ. Micr., vii. (1881) p. 161 (3 figs.).
† See this Journal, i. (1881) p. 126.

under side of the stage, for shutting off all light except a small pencil from the mirror. It may be mounted in either of two forms: the one to fit into the usual tube, which, in the cheaper Microscopes, is attached to the under side of the stage, the other to screw directly into the stage aperture.

Fig. 55.



The device is shown in Fig. 55. The milled edge serves to rotate the plate with the spiral slot over the radial slot (shown by dotted lines), thus giving varying degrees of obliquity.

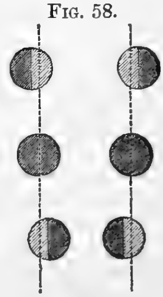
Stereoscopic Vision with Non-stereoscopic Binocular Arrangements.—It will be remembered that in his paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope,"* Professor Abbe pointed out that an orthoscopic (stereoscopic) effect was produced if the *inner* halves of the "Ramsden circles" just above the eye-pieces were shut off by diaphragms (that is like O, Fig. 56), and a pseudoscopic effect when the *outer* halves were so dealt with (that is like P, Fig. 57).

Fig. 56.

Fig. 57.

Dr. A. C. Mercer, of Syracuse, U.S.A., points out that this explanation solves a difficulty which has perplexed many microscopists, and has hitherto remained unexplained. Powell and Lealand's high-power binocular is essentially non-stereoscopic, and theoretically ought not to give any appearance of relief to the objects. It has nevertheless been frequently observed that a distinctly stereoscopic effect was obtained, and this was attributed entirely to the imagination of the observer. Dr. Mercer, however, shows that it is a true and not an illusory effect, and that it depends upon the extent to which the eye-pieces are separated.

Fig. 58.



When the eye-pieces are at such a distance apart that the Ramsden circles correspond exactly with the pupils of the eyes, centre to centre (Fig. 58), the object appears flat. If, however, they are racked down so as to be somewhat nearer together, the centres of the pupils fall upon the *outer* halves of the Ramsden circles, and we have the conditions for orthoscopic effect; while if they are racked up so as to be more separated the centres of the pupils fall on the *inner* halves and we have pseudoscopic effect.

This is quite in accordance with what takes place in the use of

* See this Journal, i. (1881) pp. 203–11 (3 figs.).

eye-pieces, the halves of which are actually covered with diaphragms, for when the inner halves are cut off the tubes naturally require to be racked down to diminish the separation of the eye-pieces, and in the converse case to be racked up; Dr. Mercer also satisfied himself by experiment as to the validity of his deductions by observing sugar pills pushed half-way through holes in black cards, the pills being marked with cross marks in pencil to increase the effect. They could be made to appear convex, concave, or flat, according to the position of separation of the draw-tubes.

We have, for simplicity, referred to the covering up of *both* halves of the eye-pieces, but it is not of course necessary to cover up more than *one*.*

In order to obtain the *best* stereoscopic effect the halves (or one of the halves) of the eye-pieces of the Powell and Lealand or other similar binocular arrangements should be actually shaded by diaphragms so as to aid in properly centering the pupils, but Dr. Mercer's object is to show that the effects observed with ordinary eye-pieces are explicable upon proper theoretical principles, and so to relieve those observers who have insisted upon the existence of true orthoscopic effects in such cases, from the reproach which has unjustifiably attached to them on account of their supposed abnormal and unscientific development of a power of drawing upon their imagination.

[The Bibliography for the period intervening between that contained in the Journal of October 1880 and the end of 1881, will be found in the Appendix to the next volume.]

ABBE's Experiments on the Diffraction Theory of Microscopical Vision.
[General Remarks.]
Journ. of Sci., IV. (1882) pp. 118–9.

Acme Microscopes. *Amer. Natural.*, XVI. (1882) p. 261.

American Society of Microscopists.
[Review of Proceedings for 1881, and remarks on the meeting at Elmira for 1882.]
The Microscope, I. (1882) pp. 175–7.

Angular Aperture.
[Letter by 'Akakia,' describing Dr. Robinson's method of measurement.]
Engl. Mech., XXXIV. (1882) pp. 454–5.

BROWNELL, J. T.—A much-needed stop.
[Suggestion for a "thumb-screw" to prevent Microscopes at Soirées being focussed too low to the injury of the slides.]
Amer. Mon. Micr. Journ., III. (1882) p. 39.

BULLOCH's New "Congress" Stand.
Amer. Mon. Micr. Journ., III. (1882) pp. 9–13 (2 figs.).

Carlisle Microscopical Society—Inaugural Address by the President, Canon Carr. *North. Microscopist*, II. (1882) pp. 17-19.

CARR, E.—*See* Carlisle.

Cheap Microscopes.
[Letter by C., advocating the encouragement of their purchase and display, and further discussion by Welborn, G., Ollard, J. A., Cooper, C. C., F., J., E. Holmes, A., E. C., and Medehanstade.]
Engl. Mech., XXXIV. (1882) pp. 470, 495–6, 520–1, 545.

COX, J. D.—Prof. Rogers' Micrometers.
Amer. Mon. Micr. Journ., III. (1882) pp. 23–5.

* See this Journal, i. (1881) p. 211, Fig. 38.

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 I. (1881) pp. 303–60.]
Journ. de Microgr., VI. (1882) pp. 44–8, 91–5 (13 figs.).

CURTIS, L.—New ½-in. Gundlach Objective of 100°.
Amer. Mon. Micr. Journ., III. (1882) pp. 19–20.
The Microscope, I. (1882) pp. 194–5. *Science*, III. (1882) pp. 19–20.

DAVIS, G. E.—The limiting Diaphragm or Aperture Shutter.
North. Microscopist, II. (1882) pp. 13–14 (2 figs.) p. 75.
Amer. Mon. Micr. Journ., III. (1882) pp. 49–50.
Engl. Mech., XXXV. (1882) p. 25 (2 figs.).

„ „ A Visit to an Objective Factory.
[W. Wray's, Highgate.]
North. Microscopist, II. (1882) pp. 21–4.

DIPPEL, L.—Abbe's Camera Lucida.
Bot. Centralbl., IX. (1882) pp. 242–3 (1 fig.).

FORREST'S (H. E.) Compressorium. *North. Microscopist*, II. (1882) p. 51.

GRIFFITH, E. H.—The Griffith Cell. *Amer. Mon. Micr. Journ.*, III. (1882) p. 9.

GUILLEMIN, A.—Le Monde Physique. Tome II. La Lumière. (The Physical World, Vol. II., Light.)
[Contains a Chapter on the Microscope (20 pp., 20 figs., and 3 coloured Plates), a section on Microscopical Photography (7 pp. and 5 figs.), and one on the Applications of Photography to the Arts and Physical and Natural Sciences, 4 pp. and 3 figs.]
8vo, Paris, 1882. 668 pp., 353 figs., and 26 plates.

HITCHCOCK, R.—Large and Small Microscopes.
[Rejoinder to C. Stodder.]
Amer. Mon. Micr. Journ., III. (1882) pp. 16–7.

„ „ The Microscopist.
[Further reply as to Stowell's 'The Microscope.']
Amer. Mon. Micr. Journ., III. (1882) pp. 18–9.

HOLMES, E.—Drawing, &c., from the Microscope.
[Recommends Mr. Dallinger's plan of drawing on finely smoothed glass.]
Sci.-Gossip, 1882, p. 39.

Journal of the Royal Microscopical Society for 1881.
[Note on the small number of original contributions to the 'Transactions' and the reason for it.]
Journ. of Sci., IV. (1882) p. 56.

Microscopical Societies.
[Note as to an intended alteration in the printing of their Reports.]
Amer. Mon. Micr. Journ., III. (1882) pp. 14–5.

MILES, J. L. W.—Dark-field Illumination by the Bull's-eye Condenser.
[Placed beneath the stage, plane side uppermost, with a spot of black paper in the centre.]
North. Microscopist, II. (1882) p. 39.

„ „ Substitute for a Revolving Table.
[A piece of table oil-cloth, 15 in. sq., the cloth side turned to polished and the oil side to painted tables.]
North. Microscopist, II. (1882) pp. 39–40.

NACHET, C. S., Death of. *Journ. de Microgr.*, VI. (1882) pp. 3–4.

Objectives, Verification Department for.
[Tabular results of measurements of objectives.]
North. Microscopist, II. (1882) pp. 7, 24, 59.

OLLARD, J. A.—Mr. Kitton's Illumination.
[Commending same, and recommending the use of distilled filtered water, filling the globe full to prevent a shaky light, and not using too much sulphur chlorate (first filtered).]
Sci.-Gossip, 1882, p. 47.

POCKLINGTON, H.—The Microscope at Home.
Engl. Mech., XXXIV. (1882) pp. 538–9, 560–1.

PRINGSHEIM'S Photochemical Microscope.
Quart. Journ. Micr. Sci., XXII. (1882) p. 86.

S., H. C.—An "English Mechanic" Microscopic Club.
Engl. Mech., XXXIV. (1882) p. 615.

SALT'S and SWIFT-BROWN Microscopes.
Engl. Mech., XXXIV. (1882) p. 463 (3 figs.).

SCHRÖDER, H.—Ueber Projektions-Mikroskope. (On Projection Microscopes.)
Centr. Ztg. f. Optik u. Mech., III. (1882) pp. 2–4, 15–17 (1 fig.).

SHIPPERBOTTOM, W.—Improvements in Photo-micrography.
North. Microscopist, II. (1882) pp. 48–9 (2 figs.) p. 75.

" " Use of the 'Aperture-shutter' in Photo-micrography.
North. Microscopist, II. (1882) p. 75.

Slow motion for Micro. Stand.
[Letter by 'Sunlight,' describing the ordinary form used with the 'Jackson Model.']
Engl. Mech., XXXIV. (1882) p. 457 (1 fig.).

STALLYBRASS, H. M.—Microscopic Illumination.
[Approval of F. Kitton's Hollow Glass Sphere Method, I. (1881) pp. 112–3—by adding a few drops of pure sulphuric acid, cloudiness of the liquid is prevented.]
Sci.-Gossip, 1882, p. 64.

STODDER, C.—Large vs. Small Stands.
[Reply to R. Hitchcock's Criticism.]
Amer. Mon. Micr. Journ., III. (1882) pp. 13–4.

SUFFOLK, W. T.—On Microscopical Drawing. *Sci.-Gossip*, 1882, pp. 49–50.

TISSANDIER.—Microscopic Photography in Paris.
[Abstr. of article from 'La Nature.']
Engl. Mech., XXXIV. (1882) p. 561.

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

Injection of Invertebrate Animals.*—G. Joseph uses filtered white of egg, diluted with 1 to 5 per cent. of carmine solution, for cold injections. This mass remains liquid when cold; it coagulates when immersed in dilute nitric, chromic or osmic acids, remains transparent, and is sufficiently indifferent to reagents. A mass of similar properties is made of glue liquid when cold, coloured with the violet extract of logwood reduced with alum. Injection is effected in the case of worms (leech and earthworm), by way of the ventral or dorsal vessel, with large Crustacea by the heart or the ventral vessel which lies in the sternal canal.

In many cases, especially when lacunar spaces have to be filled, useful preparations are obtained by natural injection (*auto-injection*, or *autoplerosia*). Natural injection of Medusæ is effected without injuring the vessels; in the case of Crustacea, Insects, and Mollusca, through a slit with an opening at the side remote from it. Medusæ are laid in a glass vessel, with the bell downwards, and a bell-jar ending in a narrow tube above is placed over it and made air-tight; after the Medusa is covered with the injection-mass, the air in the glass is exhausted, and the sea-water running out by slits in the lower side of the annular canal the coloured fluid runs in.

* Ber. naturw. sect. Schles. Ges., 1879, pp. 36–40. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 45–6.

In the case of leeches and large species of earthworms, the natural injection is made from the ventral sinus. In all cases a glass tube is used, with a finely drawn-out point. The injection is complete when the injection issues from the counter-opening.

Animals to be injected alive are kept quiet by cold (laying upon ice). Besides the animals mentioned, large caterpillars, beetles, Libellulid larvæ, locusts, &c., have served as objects for injection; the glass cannula is introduced into the posterior end of the dorsal vessel, and the counter-opening is made in the ventral vessel, and *vice versâ*.

Cold Injection Mass.*—A. Wikszemski describes a modification of Pansch's method:—Thirty parts by weight of flour and one of vermilion are mixed while dry, and then added to 15 parts by weight of glycerine and subjected to a continuous stirring until of a homogeneous viscous consistency; then 2 parts of carbolic acid (dissolved in a little spirit) are added to it, and finally 30 to 40 parts of water. This injection mass is specially adapted for subjects already injected with carbolic acid (in the proportion of $1\frac{1}{2}$ part by weight each of carbolic acid, spirit, and glycerine to 20 of water); 24 hours are allowed to elapse between the two injections. It is a good thing to introduce a little dilute injection first.

Staining with Saffranin.†—According to W. Pfitzner, staining with saffranin is most successful with chromic acid preparations which have been entirely freed from the acid, less so with substances hardened in picric acid; the only tissues suited to it are those which very readily take up colour, and these must be cut extremely thin. The sections are transferred to the staining fluid (1 part saffranin, 100 absolute alcohol, 200 distilled water) from distilled water, are again placed in distilled water after a few seconds, and then into absolute alcohol, from which they are removed at the right moment (i.e. when the nuclei are properly stained) to dammar varnish. The advantage of staining with saffranin is that it affects the nuclei exclusively. Dr. M. Flesch ‡ remarks that the advantage claimed by Pfitzner for saffranin has been shown by Hermann to be shared with it by other aniline dyes when applied in the same manner.

Staining with Silver Nitrate.—Staining with nitrate of silver is very difficult to effect in the case of marine organisms, owing to the abundance in which chlorides occur in them. R. Hertwig § meets this difficulty by washing the animals (after hardening in osmic acid) with distilled water until the water used for washing gives but a very slight precipitate with solution of silver nitrate, and then allowing a 1 per cent. solution of the nitrate to act for 6 minutes.

* Arch. f. Anat. u. Entwick., 1880, pp. 232–4.

† Morph. Jahrbuch, vi. (1880) p. 469. Cf. Zool. Jahresber. Neapel for 1880, i. p. 43.

‡ Ibid., pp. 43–4.

§ Jen. Zeitschr., xiv. (1880) p. 324.

C. Golgi,* in studying the peripheral and central nervous fibres of the spinal cord, exposes the nerves to the action of osmic acid, chromic salts, and silver nitrate, according to certain methods of combination. For example, a nerve is removed with care from a freshly killed animal (rabbit), and placed in a mixture of 10 parts of a 2 per cent. solution of potassium bichromate with 2 parts of 1 per cent. osmic acid solution. After about an hour the nerve is divided into smaller pieces of $\frac{1}{2}$ to 1 cm. in length, and again placed in the solution, where it is left some hours longer (it must be examined every 3 hours), and finally is placed for not less than 8 hours in 0·5 per cent. solution of nitrate of silver, and then mounted in dammar varnish in the ordinary way. Better preparations are produced by placing nerves which have been exposed—in the case of peripheral nerves 8 hours, of central nerves 10 to 15 days—to the action of bichromate of potash, then from 12 to 24 hours to silver nitrate, and mounted in dammar varnish without previous exposure to the light.

Staining Tissues treated with Osmic Acid.—Damaschino, in a communication † to the Société de Biologie, advocates osmic acid in the form of a solution of 1 per cent. for human spinal cord divided into lengths of 1 cm., and for the spinal cord of smaller animals treated entire; he afterwards hardens in absolute alcohol. If it is then not sufficiently hard, the preparation is saturated with gum before being placed in the alcohol; the sections, which are penetrated with gum, are transferred unstained to Canada balsam without being previously freed of gum by means of water.

Referring to this communication (which contains no really new point), L. Malassez ‡ remarks on the difficulty of staining substances which have been treated with osmic acid, and for this reason he first stains the sections with other staining matters, and then exposes them to the action of osmic acid, and this in such a way as to allow only the vapour of the solution of acid to act. He claims to have obtained admirable results by this method, since in this way all the properties of the osmic acid come into play without affecting the other staining substances.

R. Hertwig § placed the animals (Ctenophora) examined by him in a 0·05 per cent. solution of osmic acid, to which in some cases he added acetic acid solution of 0·2 per cent. for from 5 to 15 minutes, according as he wished to investigate the epithelium or the elements of the gelatinous tissue; he then stained with carmine and finally preserved in dilute glycerine.

Mounting the "Saw" of the Tenthredinidæ.||—Mr. P. Cameron describes his method of mounting and preserving the "saw" of the Tenthredinidæ for microscopical examination, a method which can be applied to microscopical mounting generally.

* Arch. per le Sci. Med., iv. (1880) pp. 221–46 (1 pl.). Cf. Zool. Jahresber. Neapel for 1880, i. p. 44.

† Gazette medic. Ann., li. (1880) p. 636. ‡ Ibid., p. 637.

§ Jenaisch. Zeitschr., xiv. (1880) p. 315. Cf. Zool. Jahresber. Neapel for 1880, i. p. 41.

|| Trans. Entomol. Soc. Lond. 1881, pp. 576–7.

With fresh specimens the saws can be extracted by pressing the abdomen, when they will be protruded and readily extracted. With old specimens it can be done equally well by placing the insect in a relaxing-dish, or, more promptly, by steeping it in water for a day, when they can be taken out in the same way as with fresh insects, the only difficulty being experienced with insects full of eggs. For their better examination the four pieces composing the ovipositor proper should be separated; after which they must be steeped in turpentine for a day or two so as to get rid of air. This is best done by enclosing them in a small folded piece of paper; and, if they be properly labelled, many different preparations can be placed in the turpentine-bottle together.

Next take a sheet of fine Bristol board, and cut it up into pieces, say 12 lines × 9 lines, and punch at one end a round or square hole, four or five lines across. On the lower side of this fasten, by means of Canada balsam dissolved in benzine, a cover-glass. When this has dried fill up half the cell thus formed with the same composition, spreading it as evenly as possible, and in it arrange your preparation. Put it aside for some hours in a place where no dust will fall on it, then fill the cell with enough balsam to run over the edge of the cell, place a cover-glass over it, and press it down. All that now requires to be done is to allow the preparation to dry, taking special care to keep it flat, to label it, and stick a pin through the card, by means of which it is fixed in the cabinet alongside the insect from which the part was taken. To examine it under the Microscope, all that is necessary to do is to place an ordinary glass slide across the stage, and put the card on it, in doing which it is not necessary to take the pin out of it if a short pin be used.

The great advantage of this plan for entomological purposes is that it does not necessitate the formation of two distinct collections, which must be the case if dissections are mounted on glass slides, which cannot of course be placed alongside the insects. Besides that, it is cheaper, more expeditious, and safer; for the cards are so light that no injury comes to them from falling, or getting loose in the box. If desired, a coloured ring can be put round the top object-glass by the turntable in the ordinary way, but except for ornament, is not necessary. The author usually prepares two or three dozen of the cards with one cover-glass on at a time, so as to have them ready for use. The object of letting the dissections harden in the cell, half filled with balsam, is that three or four separate parts may be arranged in the most suitable way in the same cell without fear of their being disarranged or injured when the top cover-glass is put on, while both might happen if the whole operation was performed at once.

For the examination of the saws, a quarter-inch objective is the best, the teeth, in some cases, are so fine that they are apt to be overlooked if lower powers are used.

Mounting Butterfly-scales.*—Dr. D. H. Briggs recommends the following process. Dissolve 1 part of Anthony's "French Diamond

* Amer. Mon. Micr. Journ., ii. (1881), p. 227.

varnish" in 2 parts of pure benzole. Apply a drop or two of the solution to a slide, and in a few seconds, or as soon as the varnish has set, press the wing of the butterfly gently upon the slide, and then carefully lift it away. The scales will be found transferred to the slide in their beautiful natural arrangement * on the wing. Make a shallow cell around the mounting and apply the cover-glass. Canada balsam must not be used, as it disarranges the object.

Imbedding Ctenophora.†—For imbedding Ctenophora (for the most part after hardening in osmic acid), R. Hertwig employs gum-glycerine very largely diluted with water; it is allowed to remain in contact with the air, with the substance to be cut immersed in it, until it has acquired the consistency of a stiff syrup. Shrinkage of the gelatinous tissue is to some extent obviated by this plan, owing to the slowness with which it absorbs the constantly thickening gum-glycerine.

Staining Living Protoplasm with Bismarck Brown.‡—L. F. Henneguy having treated *Paramœcium aurelia* with an aqueous solution of aniline brown (known in commerce as "Bismarck brown"), was surprised to see them assume a rather intense yellow brown colour, and move rapidly about in the fluid. The colour first appeared in the vacuoles of the protoplasm, and then it invaded the protoplasm itself. The nucleus generally remains colourless, and thus becomes more visible than in the normal state. Infusoria thus coloured were kept for nearly fifteen days. If a yellow-tinted *Paramœcium* is wounded or compressed so as to cause a small quantity of the protoplasm to exude, it is seen that it is really the protoplasmic substance which is coloured. All Infusoria may be equally stained with Bismarck brown, but no other aniline colours employed by the author exhibited the same property, they only stained the Infusoria after death, and some of them are in fact poisonous.

As it is generally admitted that living protoplasm does not absorb colouring matters, and that Infusoria are essentially composed of protoplasm, M. Henneguy endeavoured to ascertain whether protoplasm in general, of animal or vegetable origin, behaved in the same way in the presence of aniline brown.

A tolerably strong dose of Bismarck brown was injected under the skin of the back of several frogs. After some hours, the tissues were uniformly tinted a deep yellow, the muscular substance especially had a very marked yellow tint. The frogs did not appear in the least incommoded.

Small fry of trout placed in a solution stained rapidly and continued to swim about.

Finally, a guinea pig, under whose skin some powder of Bismarck brown had been introduced, soon presented a yellow staining of the buccal and anal mucous membranes and of the skin.

Seeds of cress sown on cotton soaked with a concentrated solution

* It should be observed that the scales will have their under sides uppermost, which is not the "natural arrangement."—Ed.

† Jen. Zeitschr., xiv. (1880) pp. 313–14.

‡ Rev. Internat. Sci. Biol., viii. (1881) pp. 71–2.

of the Bismarck brown sprouted, and the young plants were strongly stained brown; but on crushing the tissues and examining them under the Microscope it was ascertained that the protoplasm of the cells was very feebly coloured; the vessels on the contrary showed a very deep brown staining up to their termination in the leaves.

The mycelium of a mould which had been developed in a solution of Bismarck brown, was clearly stained after having been washed in water, whilst it is known that the mycelium which frequently forms in coloured solutions, picrocarmine, hæmatoxylin, &c., remains perfectly colourless.

Other aniline colours injected under the skin of frogs stained the fundamental substance of the connective tissue as deeply as did the Bismarck brown; but the cells of the muscular substance remained perfectly colourless.

The author concludes therefore that Bismarck brown possesses the property of colouring living protoplasm both in plants and animals.

Preservation of Infusoria and other Microscopical Organisms.* —A. Certes, in a note supplementary to his previous communications,† says that five years' experience has only confirmed his view of the efficacy of osmic acid and iodized serum for preparing Infusoria; but sometimes, notwithstanding precautions, the animalcules become black and opaque from a too prolonged action of the osmic acid; or, especially when iodized serum or lemon juice has been employed as a fixing reagent, mouldiness attacks the preparations either because the bottles have been badly corked or precautions for excluding germs from the preparations have been neglected.

It will be found however that ammonia ($\frac{1}{3}$) will clear preparations blackened by osmic acid, and thus the always dangerous use of cyanide of potassium will be avoided; but it is necessary to watch the operation with care, the time of immersion in ammonia being essentially variable according to the thickness of the animalcules and the quantity of osmic acid in excess.

With regard to mouldiness, it is possible, with certain precautions, to filter the liquid which holds the altered gatherings in suspension, upon pure glycerine. To increase the hardening of the animalcules, the liquid in excess is first removed and replaced by strong alcohol, by picrocarmine, or by green picrate of methyl, it is then poured gently on the glycerine, which, owing to its density, remains at the bottom of the vessel, but previously the liquid to be filtered must be briskly agitated so as to disengage the animalcules caught by their cilia in the matted fibres of the moulds.

The Infusoria thus detached fall first to the bottom. The patches of mycelium which offer more surface and consequently more resistance do not sink, or sink much more slowly. Advantage is taken of this circumstance to decant the liquid with a pipette, and to collect from the bottom of the vessel the Infusoria which, being isolated, are best adapted for observation.

* Bull. Soc. Zool. France, vi. (1881) pp. 36–37.

† See this Journal, ii. (1879) p. 331; iii. (1880) p. 847.

In default of osmic acid, filtered lemon juice may be employed; but it is necessary to follow the operation closely in order to check at the right moment the action of the reagent, which should be employed in a strong dose, and which consequently would in the long run injure the extremely delicate tissues of the Infusoria.

Impregnation by chloride of gold is generally successful after the action of lemon juice. Often, however, the pulverulent deposit gets entangled in the cilia of the Infusoria and obscures observation. Filtration upon glycerine reduces this inconvenience.

In conclusion, M. Certes indicates the process which he considers best for preserving the intestines of Batrachians with the object of examining the parasites they enclose. Having tied the intestine at the two extremities, it is washed in distilled water and placed in a solution of osmic acid (1–1000). After twenty-four hours' immersion, this solution is replaced by strong alcohol or by glycerinated water. Under these conditions, Opalinæ and other inhabitants of the rectum of Batrachians may be kept undistorted till they can be examined.

In a subsequent paper,* the author mentions that he has met with difficulties in the latter process. When the walls of the intestine are too thick or are too much filled by food, there is so great an absorption of the reagent that the Opalinæ and other parasitic Infusoria are dissolved under the action of the liquids of the organism or by the preservative liquids. He thinks it will be found sufficient to increase the strength of the osmic acid solution, and to slit the intestine longitudinally.

Staining the Nucleus of Infusoria.†—A. Certes has already shown ‡ the property possessed by cyanin or chinolin blue (and Bismarck brown) of staining living tissues, the nucleus of Infusoria not, however, appearing to be coloured either during life or even several hours after death. Dr. Henneguy having pointed out to him the analogous properties of a methyl violet, known as dahlia, M. Certes has repeated his experiments with several violets, and has found that, notwithstanding their very similar chemical composition, their action varies considerably. Some are always toxic, and for all species of Infusoria. Others only stain certain species out of those living in the same liquid. Others—and this is the special object of his further communication—stain the nucleus of living Infusoria, and more strongly than the rest of the protoplasm. In general with the violets in question, the cilia are always stained, and the liquid of the contractile vacuole often participates (so far as could be judged) in the general colouring.

The phenomena of selection of the colouring matter in regard to the nucleus was clearly established, at first with B B B B B violet on *Balantidium* from the intestine of *Bombinetor igneus*, and then on *Paramecium*, *Vorticella*, &c., with the same and dahlia violet. Gentian

* Bull. Soc. Zool. France, vi. (1881) p. 228.
† Ibid., pp. 226–7.
‡ See this Journal, i. (1881) pp. 527, 694.

and 50 N violet on the contrary, notwithstanding their great colouring power, did not exhibit any selective action with the nuclei.

As to the greater or less resistance which very closely allied species oppose to the action of the same reagent, the author mentions that he has found small species of *Paramecium* continue to live indefinitely without staining, whilst all the others of equal or greater size had entirely disappeared from the same liquid.

The staining of the nucleus of the Infusoria is, the author (erroneously) says, " a new fact, and it is so much the more interesting to note that the most recent researches demonstrate the preponderating part which the nucleus plays in the phenomena of nutrition and reproduction, and, if one may so say, in the government of the life of unicellular organisms."

Aniline Dyes and Vegetable Tissues.*—Mr. J. M. Macfarlane, in a paper on the action of some aniline dyes on vegetable tissues, records some of the more important methods arrived at.

" *Staining of Laticiferous Vessels.*—Every botanist must have experienced the difficulty of obtaining thoroughly good preparations of laticiferous vessels. Sachs recommends boiling in dilute potash; but, while tolerably good sections may be obtained in this way, several difficulties are encountered. The points to be aimed at in preparing this tissue are (*a*) the coagulation of the latex, so that it may continue to fill the vessels; (*b*) the staining of the cut sections, so that the vessels may be distinctly differentiated from the surrounding cellular substance; (*c*) the successful mounting of these, so that the tint may be permanently retained. The first part of the process is best accomplished by obtaining, for example, a large and entire root of *Scorzonera*, so that extensive bleeding may be prevented. A suitable sized bottle being filled with alcohol, pieces of the root from one to two inches in length are cut and immediately placed in it. Coagulation of the latex is quickly effected. After lying thus for a week or longer, sections are cut with the hand, or by aid of a microtome. The second point is most important, and on its success the beauty of the object will depend. The sections are placed in alcoholic solution of saffranine, obtained by dissolving 1 part of this dye in 800 parts spirit. After 18 to 24 hours, they are removed from the stain and decolorized by washing repeatedly in spirit. It will be found that the stain leaves the cellular tissues rapidly, while it is retained by the latex in the vessels. We will notice, lastly, the best method for mounting these. While such media as balsam or dammar would cause unnatural contraction, fluids, on the other hand—especially acetic acid solution—are apt to act slightly on the dye. I have found nothing to equal glycerine jelly, as it preserves the tint and is easily worked.

Double Staining of Stems, &c.—The dyes usually recommended for this purpose are rosaniline and iodine green; but saffranine and emeraldine are preferable, as the former is, for vegetable tissues, a

* Trans. Bot. Soc. Edin., xiv. (1881) pp. 190–1.

most permanent dye, while the latter imparts a brighter colour than iodine green.

Staining of Cell Contents.—While some aniline dyes act specially on the thickened walls of cells, others are extremely useful for demonstrating the structure of protoplasm. Heliocin and naphthaline in this respect are valuable; and eosin, though not an aniline dye, is equally so. For epidermis cells and ordinary parenchyma the latter is preferable. It is best prepared by dissolving 1 part in 1200 of alcohol. The specimens are allowed to lie for 5 minutes in the stain, and are then washed in water and mounted in a cell with acetic acid, or Goadby's solution. The cells of *Spirogyra*, however, have their minute structure beautifully revealed by treatment with heliocin. The following is the best method to adopt:—Decolorize the filaments by placing them in a 1 per cent. solution of chromic acid for two days; add then to the solution 1 part in 2000 of the dye, and shake slightly, so that it may dissolve equally. In an hour the filaments will be ready for examination or permanent preparation."

Indol as a reagent for Lignified Cell-membrane.*—Max Niggl gives a *résumé* of the observations of previous observers on the use of indol as a reagent for testing the lignified condition of the cell-wall, supplemented with additional observations of his own.

If a section of a branch is treated with dilute hydrochloric acid, and an alcoholic solution of indol added, the lignified cells acquire a beautiful cherry-red colour, while the non-lignified cells of the cambium, cortex, and epidermis remain uncoloured. The use of hydrochloric acid is, however, for several reasons inconvenient, and the author prefers the use of dilute sulphuric acid of sp. gr. 1·2 (1 vol. English sulphuric acid with 4 vols. water). The best mode of procedure is as follows:—Pure indol is dissolved in warm water. The section is moistened with a drop of this solution, and covered with a cover-glass. The indol is then removed by blotting-paper, and a drop or two of the dilute sulphuric acid run in. Wherever this comes into contact with the indol which permeates the section, the lignified cell-walls take a beautiful cherry-red, the sclerenchymatous cells even a purple colour, which is retained by the preparation for a considerable time. If the acid used is too concentrated, or the excess not removed, the colour passes, after some weeks, to brownish red.

Among Thallophytes, Niggl found, by the use of this reagent, no trace of lignification in algæ, or in the majority of fungi; it was only present in the cortical and medullary layers of a few lichens.

In vascular plants the cuticle is as a rule uncoloured by indol. In many plants (contrary to the statement of other observers), the walls of the guard-cells of stomata appear to be strongly coloured. This is also the case with cork, except that in older cork-cells the middle lamella gives indications of lignification. With very few exceptions collenchyma also shows no colouring with indol. The author enters into considerable detail with regard to the colouring of the various elements of parenchyma, and of sclerenchyma. A charac-

* Flora, lxiv. (1881) pp. 545–59, 561–8.

teristic property of tracheids is the very early and strong development of lignification in their cell-walls. In the walls and disks of sieve-plates, on the contrary, indol produces not the least reaction.

Protoplasm acquires a slight rose-colour with indol and sulphuric acid, but no differentiation of the nucleus is observable; the contents of the stinging hairs of the nettle assume throughout a red colour. No effect is produced on the contents of resin-passages.

The author concludes that the red colour imparted by indol and sulphuric acid is an unfailing test for the lignification of the cell-wall.

English's Method of Preserving Hymenomycetes and Wild Flowers.*—When we mention that the price of this book is 7*s.* 6*d.*, and that each of the two sections only contains as much matter as two columns of the *Times*, it will be obvious that it cannot be abstracted without seriously interfering with its proprietor's expected profits. We therefore confine ourselves to generalities.

For Fungi, a double preservative compound is used, formed of British farina, methylated spirit and corrosive sublimate, oxalic acid and sulphur. There is also an "adjunct to the process," formed of plaster of Paris and sulphur, for imbedding the specimens after the preservative has been applied. The final process consists of varnishing. Waxing and colouring can also be adopted if desired, for which directions are given.

The process for flowers (which has only been tried for two years) is to imbed them in plaster and lime as an absorbent, and gradually heat them up to 100° F. After dusting, they are varnished with similar varnish to that used for Fungi.

Mounting Salicine Crystals.†—Dr. D. H. Briggs recommends the following process:—

Clean the slide perfectly with ammonia, then rinse with hot water and cleanse with ammonia again.

Add to the salicine from one-tenth to one-twentieth its weight of pulverized gum arabic. Make a nearly saturated solution of the salicine and gum in distilled water, or in ice-water heated to the boiling point, and carefully filter the solution. Heat the solution to 100° C. in the beaker, and pour the hot solution upon a still hotter (*sic*) slide, and drain off. Only a hot solution will give bright colours.

Hold the slide, and watch for disks of crystals. As soon as these appear, place the slide on a cold iron block.

A rim is put on the crystals by another heating over the lamp and another cooling on the iron. Without delay heat a drop of Canada balsam on a circular cover-glass, and apply the cover to the crystals, and fasten with white zinc cement on a turntable.

The process described, if followed with care, will yield most

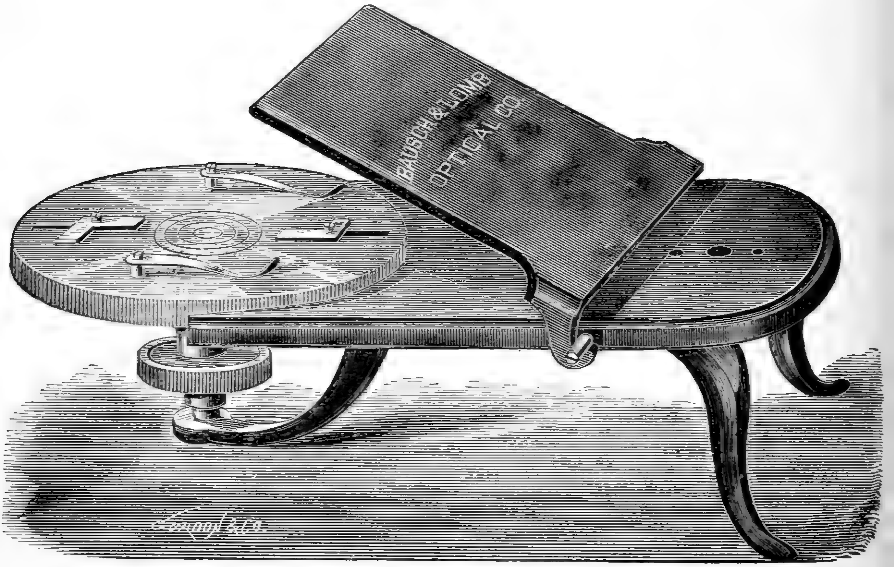
* English, J. L., 'A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers.' viii. and 41 pp. 8vo. Epping, 1882.

† Amer. Mon. Micr. Journ., ii. (1881) pp. 227–8.

excellent results; perfect rosettes of crystals can be readily obtained, giving brilliant effects with polarized light.

Bausch and Lomb Turntable.—We have no description of this turntable, but so far as we can gather from the drawing (Fig. 59), it

Fig. 59.



differs from other turntables in being provided with a hand rest, which can be adjusted to any convenient height.

Griffith Cell.*—Mr. E. H. Griffith places the slide on a turntable, and with white-zinc cement turns a circle on the centre if for a transparent mount, or a disk if for an opaque one, then centres to the circle or to the disk a common curtain ring, and immediately paints the ring with the cement, taking care not to push it from its position. When dry, the cement will hold the ring very firmly, so that there need be no fear that it will break off.

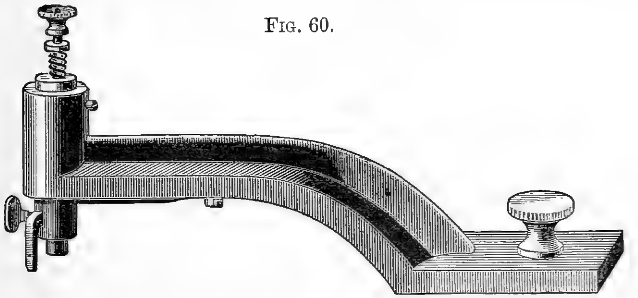
If a shallow cell is desired the rings may be flattened easily; or if a deep one is required, several rings may be securely fastened one above the other by painting each one in succession. If the cement does not flow readily add benzole; and in case the cell becomes rough, dip the brush in clear benzole and smooth it. Use a brush well filled with the cement to secure a smooth background. With a little practice a person may easily make fifty beautiful and practical white cells in one evening, and in a few hours they will be hard and ready for use. When the cover-glass is to be fastened, a little of the

* Amer. Mon. Micr. Journ., iii. (1882) p. 9.

cement is easily applied. When dry, the slide may be finished with colours prepared from tube paints mixed with benzole balsam, or with dammar and benzole. Before mounting, if a dark background is desired, a disk of asphalt of any desired size turned in the centre of the ring will be found convenient. Over the asphalt a small-sized cover-glass may be used for the object to be placed upon, or the asphalt may be covered with shellac when dry. The object may be fastened with gelatine or gum arabic, or made to adhere to the coat of shellac before it becomes dry.

Bausch and Lomb Circle Cutter.*—This instrument for cutting circles of thin glass (Fig. 60) is intended to be attached to the turntable, by means of the screw shown at the right of the figure, so

Fig. 60.



that the cutting point stands over the turning plate. The thin glass is placed upon the turntable and held by the central pin which then revolves with the glass. A gentle pressure causes the cutting point to touch the glass, and perfect circles can thus be readily obtained.

Wax and Guttapercha in Dry Mounting.†—Prof. W. A. Rogers, of Harvard College Observatory, writes:—"Notwithstanding the general condemnation of wax as a cement for covers in dry mountings, it is doubtful whether the objections urged against its use are altogether valid. I have had rather more than my share of experience in unsuccessful mountings of this class. During the past five or six years, I have been engaged upon the problem of the exact subdivision of any given unit into equal parts. Whatever success I may have gained in this direction has, I suspect, been somewhat more than counterbalanced by the deterioration of the ruled plates through the condensations which have formed under the covers.

"I have lately collected quite a large number of these plates for the purpose of studying the characteristic defects of different kinds of mountings. As the result of this study, I have reached the conclusion that, for the most part, the primary cause of the condensations which form under the covers, is the moisture remaining upon the glass after the operation of mounting. No matter how thoroughly a glass slide

* Amer. Mon. Micr. Journ., ii. (1881) pp. 225–6 (1 fig.).
† Ibid., p. 190.

may be rubbed, if it is immediately held over a flame, a certain amount of moisture will appear.*

"The evaporation from certain kinds of cement, without doubt aggravates the difficulty, and probably this is, in some cases, the independent cause of 'sweating.'

"Nearly all of the slides examined were prepared in the following way: First, the cover-glass being held in position upon the slide by a clip, the moisture was expelled by heating. After the glass had become sufficiently cooled, small bits of white wax were placed around the edge of the cover-glass. The blunt point of a heated piece of metal was then passed slowly around the cover, and the melted wax flowed under it, far enough to hold it in position. The larger number of the slides prepared in this way were found to be well preserved. When, however, rings of cement were turned upon the slides, the protection was in almost every case less perfect. In every case in which shellac with anilin colouring was used, condensations on the under side of the cover-glass were found. The covers of several slides were removed, and in no case was there any sweating found upon the surface of the slide.

"About eighteen months ago, my attention was called to the use of sheet guttapercha rings for dry mounting. My first experience with these rings was not altogether satisfactory. It is now evident that I did not, at first, apply sufficient heat to expel all of the moisture between the cover and the slide.

"After an experience of several months, I am convinced that slides prepared in the following way, will remain in a perfect state of preservation for any length of time. Use guttapercha rings having a thickness of about one five-hundredth of an inch, and a diameter about one-twentieth of an inch less than that of the cover-glass. Hold the cover in position upon the ring with a light clip, while the guttapercha is being melted by a gentle heat. If too much heat is applied at first, the ring will lose its normal shape. After the guttapercha is thoroughly melted, the slide should be heated sufficiently to expel every particle of moisture from under the cover. While the slide is hot apply white wax to the surface, the melted wax will run under the cover and will be stopped by the ring. After covering, the wax can be removed from the surface of the glass with turpentine.

"I shall esteem it a favour to be informed of any case in which a ruled plate, mounted in this way, has failed to remain in good condition."

Aeration of Aquaria.—Mr. J. W. Stephenson points out that it is impracticable to effectually aerate an aquarium in the way suggested by M. Künckel d'Herculais, *ante*, p. 131. The only really effectual method is to direct a very fine stream of water at a high velocity obliquely upon the surface of the aquarium at about the distance of an inch. By this means air in the finest possible state of subdivision is carried some distance below the surface with the result of ensuring a thorough aeration of the whole contents.

* But will not moisture always appear on glass placed over a candle or other flame, through water being formed by the union of hydrogen with the oxygen of the air?—Ed.

It was by this method that Mr. Stephenson was able to keep the water in his marine aquarium so pure that (in 1867) he hatched the spotted dog-fish and (in 1870) herring from the egg, which had not previously been accomplished. The former was hatched at the expiration of five months and nine days, and the latter of ten days, after the eggs were placed in the aquarium.

The object of M. Künckel d'Herculais was apparently to devise a means of aerating a *marine* aquarium by means of a fall of *fresh water*, but the extra quantity of sea-water required to aerate an aquarium in the way proposed by Mr. Stephenson is not likely to present any difficulty, as it is easy to devise a plan by which a constant circulation can be maintained between the reservoir and the aquarium, without loss of water taking place.

Reference may also be usefully made to an article by Mr. C. J. Watson on "a simple mode of aerating small marine aquaria,"* in which he also describes a method of injecting air by the fall of a small quantity of fresh water.

Boyd, J.—How to Make Wax-cells.
[F. Barnard's method, III. (1880) p. 860–1.]
Sci.-Gossip, 1882, pp. 59–60.

Brittain, T.—Micro-fungi: when and where to find them.
North. Microscopist, II. (1882) pp. 15–16.

Bryan, G. H.—How to label Microscopic Slides.
[Instead of one thin paper label at one end, use two made of slips of thick card 1 in. by ½ to ¾ in.—they can then be placed one against the other without the glass of one slide touching the cover of the next, and hence there is no need of a cabinet, as any box of a suitable size will do.]
Sci.-Gossip, 1882, p. 64.

Crumbaugh, J. W.—Our Histological and Pathological Laboratories. II.
[Views as to what should constitute a good working laboratory.]
Amer. Mon. Micr. Journ., III. (1882) pp. 37–9.

Cunningham, K. M.—Cleaning Diatoms.
Amer. Mon. Micr. Journ., III. (1882) p. 14.

D., A. J.—Improvements in Turntables.
[Improvement by W. D. Smith in Kinné's self-centering turntable—explanation unintelligible.]
North. Microscopist, II. (1882) pp. 74–5.

Eger, L.—Der Naturalien-Sammler. Praktische Anleitung zum Sammeln, Präpariren, Conserviren organischer und unorganischer Naturkörper. (The Collecting Naturalist. Practical Guide to the Collection, Preparation, and Preservation of organic and inorganic Natural Objects.) 5th Ed. 8vo. Vienna, 1882, pp. iii. and 221. 37 figs.

English, J. L.—A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their natural condition, by a new and approved Method; also a new Process for the Preservation of Wild Flowers. viii. and 41 pp. 8vo. Epping, 1882.

Heurck, H. van.—Immersion Fluids.
[Transl. of paper in 'Bull. Soc. Belge Micr.' See Appendix.]
Amer. Mon. Micr. Journ., III. (1882) pp. 26–8.

Hey, W. C.—Pond-collecting in Mid-winter.
[Reports result of fishing some ponds near York on 2nd January.]
Sci.-Gossip, 1882, p. 31.

Laspeyres, H.—Ueber Stauroskope und Stauroskopische Methoden. (On Stauroscopes and Stauroscopic Methods.)
Zeitschr. f. Instrumentenk., II. (1882) pp. 14–24 (3 figs.).

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* Midl. Natural., iii. (1880) p. 270.

MALBRANCHE, A.—Réactifs pour l'étude des Lichens. (Reagents for the study of Lichens.) *Rev. Mycol.*, IV. (1882) pp. 9–10.

Microscopic Curiosity.
[Working steam-engine so small that a thimble will cover it.]
Amer. Mon. Micr. Journ., III. (1882) p. 19.

Mounting Class of Manchester Microscopical Society.
[Report of meeting.]
North. Microscopist, II. (1882) p. 40.

NIGGL, M.—Das Indol ein Reagens auf verholzte Membranen. (Indol, a Reagent for Lignified Membranes.)
[Abstr. of original article in 'Flora,' LXIV. (1881) pp. 545–59, 61–6.]
Bot. Centralbl., IX. (1882) pp. 284–5.

REINSCH, H.—Detection of Boric Acid, Silica, and certain Metals by means of the Microscope. *Journ. Chem. Soc.*, XLII., Abstracts, (1882) p. 245, from *Ber. Deutsch. Chem. Soc.*, XIV. 2325–31.

S., W. J.—Mounting for Hot Countries.
[Inquiry for hints as to mounting in Canada Balsam and Dammar Varnish in India, and statement of difficulties experienced.]
Sci.-Gossip, 1882, pp. 39–40.

SEMPER, C.—Bemerkungen zu Herrn Dr. Riehm's Notiz "Eine neue Methode der Trockenpräparation." (Remarks on Dr. Riehm's note on "a new method of dry preparation.") *Zool. Anzeig.*, V. (1882) pp. 144–6.

STOCKER, G.—Preserving Flowers. *Sci.-Gossip*, 1882, pp. 65–6.

STOWELL, C. H.—Laboratory Notes (*contd.*).
[Examination of sputa in suspected cases of phthisis, &c.]
The Microscope, I. (1882) pp. 172–4 (1 fig.).

VORCE, C. M.—The Detection of Adulteration in Food. V. Red-pepper and Turmeric. VI. Butter.
Amer. Mon. Micr. Journ., III. (1882) pp. 1–6 (1 pl.) pp. 21–3 (5 figs.).

WALMSLEY, W. H.—Some Hints on the Preparation and Mounting of Microscopic Objects. 2nd paper.
[Mounting in balsam in cells.]
The Microscope, I. (1882) pp. 161–72 (7 figs.).

WARD, E.—Micro-crystallization.
[Describes the mode of preparation of Micro-crystals.]
North. Microscopist, II. (1882) pp. 25–33.

WHITE, M. C.—Examination of Blood-stains by Reflected Light.
[With Beck's (vertical?) illuminator and $\frac{1}{8}$ in. objective.]
Amer. Mon. Micr. Journ., III. (1882) p. 6.

WIGHTMAN, G. J.—Crystallized Fruit Salt.
[Recommended as an object for the Polariscope.]
Sci.-Gossip, 1882, p. 64.

WORONIN, —.—Les meilleurs Liquides Conservateurs pour les Préparations Microscopiques. (The best preservative liquids for microscopical preparations.)
Rev. Mycol., IV. (1882) p. 71.

ZIMMERMANN'S (O. E. R.) Mykologische (mikroskopische) Präparate. (Mycological—microscopical—preparations.)
[General description by G. W.]
Hedwigia, XXI. (1882) p. 5.

PROCEEDINGS OF THE SOCIETY.

Annual Meeting of 8th February, 1882, 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 11th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Reinsch, P. F.—Neue Untersuchungen über die Mikrostruktur der Steinkohle des Carbon, der Dyas und Trias. viii. and 124 pp. and 94 pls. 4to. Leipzig, 1881..	*Mr. Crisp.*
Iris-Diaphragm for Objectives	*Mr. C. Collins.*
Sections of Sugar-cane and Palm	*Dr. B. W. Richardson.*

The President, referring to Professor Reinsch's book, said it would be very desirable to have the mounted specimens which had been promised by him.* Without these it was impossible to determine whether the conclusions at which he had arrived were correct.

Mr. Crisp said that with regard to Dr. Richardson's slides it should be noted that the processes which he quoted as having been devised by Dr. Stirling were in reality due to Dr. H. Gibbes, whose descriptions had been taken by Dr. Stirling without acknowledgment of their original source.

Mr. Crisp also called attention to the Iris-diaphragm for objectives presented by Mr. C. Collins. The use of such a diaphragm had been originally suggested by Dr. Royston-Pigott, but was now revived by Mr. G. E. Davis, for the special purpose of obtaining penetration with wide-angled objectives by reducing their aperture (see p. 262).

The Treasurer, Dr. Beale, F.R.S., read his statement of the income and expenditure of the Society for the past year, which had been duly audited by the Auditors appointed at the last meeting (see p. 292).

Dr. Gray moved that the statement be received and adopted; and Mr. Michael having seconded the motion, it was put from the chair and unanimously carried.

A vote of thanks was given to the Treasurer and the Auditors.

The President, in pursuance of notice given at the previous meeting, read the proposed alteration in the Bye-law relating to the payment of subscriptions. He thought the alteration was one which would commend itself to the Fellows.

Mr. Crisp then moved that the words from "Fellows" to "year"

* See Journal, i. (1881) p. 712.

inclusive be omitted from Bye-law No. $6a$,† and the following inserted: —" A Fellow elected in any month subsequent to February shall not, " however, be called upon for the whole subscription for the current " year, but for a proportional part thereof only; that is, if elected in " March or April he shall pay one pound fifteen shillings, in May or " June one pound eight shillings, in October fourteen shillings, or in " November or December seven shillings."

This was seconded by Mr. T. Charters White, and carried.

The Report of the Council was read by the President (see p. 293).

Mr. T. Charters White moved that the report be received and adopted and printed in the usual way, and the motion having been duly seconded, was put to the Meeting, and carried unanimously.

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—Prof. F. M. Balfour, M.A., F.R.S.; *Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *Robert Hudson, Esq., F.R.S., F.L.S.; John Ware Stephenson, Esq., F.R.A.S.

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

Secretaries—Charles Stewart, Esq., M.R.C.S., F.L.S.; Frank Crisp, Esq., LL.B., B.A., V.P.L.S.

Twelve other Members of Council—*Ludwig Dreyfus, Esq.; Charles James Fox, Esq.; James Glaisher, Esq., F.R.S., F.R.A.S.; *J. William Groves, Esq.; A. de Souza Guimaraens, Esq.; John E. Ingpen, Esq.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; *John Millar, Esq., L.R.C.P. Edin., F.L.S.; *William Thomas Suffolk, Esq.; Frederic H. Ward, Esq., M.R.C.S.; T. Charters White, Esq., M.R.C.S., F.L.S.

Mr. Beck and Dr. Gibbes having been appointed Scrutineers, proceeded to take the ballot, and subsequently reported that the above-mentioned Fellows were all duly elected. A vote of thanks to the Scrutineers was unanimously carried.

Mr. Beck said it had been usual to regard a vote of thanks to the Secretaries as a matter of course, but he thought that at no previous time did they so much deserve that a hearty vote of thanks should be offered to them. The Society was very greatly indebted for their services, and it was not as a mere matter of form that he made the proposition that they should be thanked for the able manner in which the business of the Society was conducted.

The President thought there could be no difference of opinion upon this matter. The Secretaries were the very life and soul of the Society, and most heartily deserved their thanks. The motion was then put from the chair, and carried by acclamation.

Mr. Crisp in returning thanks for the vote on behalf of himself

† See Journal, iii. (1880) p. 736.

* Have not held during the preceding year the office for which they were nominated.

and his co-secretary, said that he felt there should be an amendment to the proposition so as to make it include the President and the other Officers of the Society instead of singling out the Secretaries alone. The President in particular had been most indefatigable in the attention which he had given to the affairs of the Society, and had especially distinguished himself by the way in which he had added by his comments to the interest of the matters brought before their meetings. There was he knew a very general desire that his term of office might be an extended one.

The President then read his Annual Address, which was warmly applauded by an appreciative audience (see p. 145).

Mr. Ingpen said he had much pleasure in proposing a vote of thanks to the President for his able and interesting address. He was sure that those who had followed the revival of the discussion of the aperture question would thoroughly agree that the last year had, as the President had observed, marked an important epoch, in that it had placed the matter on its true scientific basis, and had exposed the strange fallacies by which the previous consideration of the subject had been confused. The Address was one which he felt sure they would all be pleased to read when printed, and to remember. For his own part, he would venture to express the hope that the President would carry out his intention of continuing his record of progress in a similar manner at a future time.

Dr. Braithwaite having seconded the motion, Mr. Ingpen put it to the Meeting, and declared it carried by acclamation.

The President thanked the Fellows for the vote of thanks and also for the honour which they had done him in again electing him President. He had at first been doubtful as to how he should succeed in that office, for although he had occupied the Chair in other societies, he had been prevented from attending the meetings of this Society. He could only say that he would do his best during the term of office for which they had re-elected him, and hoped that at its termination he should receive their approval.

New Fellow.—Mr. W. A. Thoms was elected an *Ordinary* Fellow.

THE TREASURER'S ACCOUNT FOR 1881.

Dr.

1881.	£	s.	d.
To Balance brought from 31st December, 1880	102	18	8
,, Interest on Investments	84	15	9
,, Admission Fees	107	2	0
,, Annual Subscriptions	563	16	0
,, Composition	10	10	0
,, Journals sold by Assistant Secretary	2	11	0
,, Monthly Microscopical Journal (odd numbers) sold	11	11	6
,, Screw tools sold	12	12	6
,, Consols sold (Medal Funds)	198	10	0
	£1094	7	5

Cr.

1881.	£	s.	d.
By Rent, Gas, and Attendance	100	3	9
,, Salaries, Reporting, and Commission	142	19	6
,, Books and Binding	44	5	4
,, Expenses of Journal	339	4	0
,, Stationery and Miscellaneous Printing	13	3	3
,, Coffee at Evening Meetings	23	5	6
,, Fire Insurance	1	4	0
,, Cheque Book and Power of Attorney	0	15	8
,, Petty Cash and Postage of Journal (including balance in hand 5*l.* 9*s.* 4*d.*)	65	0	0
,, Alterations to Library	14	3	4
,, Screw tools	26	5	0
,, Medal Funds returned	200	0	0
,, Subscription to Mr. Bolton's Bottles	2	2	0
,, Cheque returned and Bank Charges	1	1	6
,, Balance remaining 31st December, 1881	120	14	7
	£1094	7	5

L. S. Beale, *Treasurer.*

Investments, 31st December, 1881.

1200*l.* Freehold Mortgages. 1057*l.* 13*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Account examined and found correct, February 3rd, 1882.

J. Badcock, P. S. Butler, *Auditors.*

REPORT OF THE COUNCIL

presented to the Annual Meeting on 8th February, 1882.

New Fellows.

Having regard to the large number of new Fellows elected during the years 1879 and 1880, it might have been fairly expected that the new elections would now show some diminution. The Council are, however, gratified to find that during the past year 51 Ordinary Fellows were elected, as against 47 in 1880 and 58 in 1879.

Twenty-four Fellows have died or resigned (1 compounder, 22 subscribers, and 1 Honorary Fellow), and the list now stands as follows :—501 Ordinary, 49 Honorary, and 83 Ex-Officio Fellows.

The greatest number of Ordinary Fellows at any previous period of the Society's existence was 452.

Finances.

The income of the Society (excluding admission fees) now amounts to 728*l.*, being 636*l.* 6*s.* derived from subscriptions, and 91*l.* 14*s.* from investments. In accordance with the determination come to at the Annual Meeting in 1881, it is not intended in future to invest Compositions, except in the contingency mentioned in the Council's last Report.

Library, &c.

The additions to the Library are now so numerous that there is a difficulty in providing space for them on the shelves, and it is feared that the only remedy will be to discontinue some of the exchanges.

A catalogue of the Library has been prepared by the Assistant-Secretary, and checked by Mr. Fox, who has also kindly undertaken to prepare a catalogue of the property of the Society generally.

Meetings.

The attendance at the meetings of the Society has been well maintained, and if the Council were furnished with a greater number of papers, recording the results of original work on the part of Fellows, the position of the Society would leave hardly anything to be desired.

The Journal.

In accordance with the desire expressed by the Council, the last volume of the Journal has been somewhat reduced, and would have been brought within the limit of 1000 pages but for the pressure caused by the revived discussion of the aperture question.

With the completion of that volume Mr. Crisp's arrangement for the honorary editorship of the Journal terminated. The Council passed a unanimous resolution expressing their thanks for his valuable services in conducting and editing the Journal, and for the great liberality he had displayed in its production. Under the special circumstances which existed, the Council did not feel themselves able to invite Mr. Crisp to continue to act as Editor; but having appointed a committee to confer with him on the subject, they were gratified to find that he was willing to continue the existing arrangement for two years further. The Council are sure that the Society will cordially endorse both their resolution as to the past conduct of the Journal and their satisfaction that it will be continued for a further period. The thanks of the Society are also due to the Associate Editors for their services in connection with the Journal.

MEETING OF 8TH MARCH, 1882, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (PROFESSOR P. MARTIN DUNCAN, F.R.S.) IN THE CHAIR.

The **Minutes** of the Annual Meeting of 8th February last were read and confirmed, and were signed by the President.

The **List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Arnold, J. A. F.—Die neueren Erfindungen und Verbesserungen in betreff der Optischen Instrumente. 232 pp. and 4 pls. (8vo. Quedlinberg, 1833)	*Mr. Crisp.*
Diatomaceous Earths from California	*Mr. H. G. Hanks.*

The **President** said that the Council had approved (under the 15th Bye-law) the recommendations of two Honorary Fellows to fill the vacancies in the list caused by the deaths of Messrs. Schleiden and Schwann, viz. (1) M. C. Robin, of France, well known as an histologist and microscopist, and the author of the 'Traité du Microscope et des Injections'; and (2) Dr. L. Dippel, of Germany, also an eminent microscopist, and the author of 'Das Mikroskop und seine Anwendung,' in which not only the Microscope but the histology of plants is ably dealt with.

Mr. J. Mayall, jun., described Wenham's Universal Inclining and Rotating Microscope exhibited by Messrs. Ross (see p. 255).

Mr. Crisp exhibited and described the Bausch and Lomb Optical Company's Trichinoscope (see p. 258); the "Hampden" Portable Simple Microscope, lent by Sir John Lubbock, Bart. (see p. 258); two cheap American "Dissecting Microscopes"; one of Fasoldt's 19-band test-plates; Aylward's "Patent Micro-slide"; and Stokes's Tadpole-slide (see p. 110).

Mr. R. J. Lecky's note as to the origin of the glutinous character of spiders' webs was read.

Mr. Crisp described the composition of the two immersion fluids sent by Dr. Van Heurck, and exhibited at the December meeting (see pp. 133 and 264).

Dr. Ord described and figured on the black-board certain symmetrically-placed large nerve-fibres which he had discovered in the spinal cord of the pike, the axis-cylinders of these animals being of enormous size, at least seven or eight times the diameter of the largest axis-cylinder found in the human spinal cord, or so far as is known in any of the higher mammalia.

Mr. Stewart said that the presence of the large fibre described by Dr. Ord with its proportionately large axis-cylinder was a matter of considerable interest, and that he looked forward to Dr. Ord's further investigations, so that its connections might be determined and data derived for understanding its chief function.

The President said they were greatly indebted to Dr. Ord for his description and drawings, and expressed the hope that he would be able to lay before them during the present session the results of his further investigations so that they might be published in proper form.

Dr. Ord, in reply to a question as to the way in which he prepared the cords referred to, said that they were partly prepared with strong spirit, and partly with Müller's fluid with a considerably long immersion. For those that he was now preparing he used a bichromate of ammonium solution.

Mr. Crisp referred to the objection that had been raised to homogeneous-immersion objectives as regards their liability to be scratched (see p. 264).

Dr. Edmunds said that he had used homogeneous lenses from their earliest introduction, and that the surfaces of the front lenses were still as highly polished, and the objectives in fact in all respects as perfect now as they were at first.

Dr. A. S. Mercer's views as to stereoscopic vision with non-stereoscopic binocular arrangements were explained by Mr. Crisp (see p. 271).

Mr. Stewart described and exhibited a gold-stained preparation of the crop of a snail, showing the nerve-termination having occasional large nerve-cells (in groups of rarely more than two) connected with it. From these large fibres spring, and there were others much smaller with groups of nerve-cells, from which again proceeded fibres of exceeding minuteness, forming a dense intercommunication with a few mostly elongated nerve-cells connected with them. The latter was apparently the terminal nerve-plexus, and lay immediately beneath the epithelial lining of the pharynx.

The President said he was grateful to Mr. Stewart for so interesting a demonstration, which opened up a field well deserving the attention of some of the younger Fellows.

Mr. Stewart said that he did not in these experiments recognize the termination in the muscle-fibres, but that some of them do so there was no doubt.

Mr. Crisp, referring to a paragraph in the President's Address, explained the misconception involved in the use of miniatured images, so far as regards the supposition that thereby very minute fractions of an inch were visible.

The President announced that the Second Conversazione of the session would be held on the 26th April.

The following Instruments, Objects, &c., were exhibited:—

Mr. Bolton:—Various Rotifers.

Mr. Crisp:—(1) Bausch and Lomb Optical Co.'s Trichinoscope (p. 258). (2) Two cheap American "Dissecting Microscopes." (3) Fasoldt's 19-band Test-plate. (4) Aylward's "Patent Micro-Slide." (5) Stokes' Tadpole Slide (p. 110).

Sir John Lubbock, Bart.:—The "Hampden" Portable Simple Microscope (p. 258).

Dr. Ord:—Preparations illustrating his paper.

Messrs. Ross:—Wenham's Universal Inclining and Rotating Microscope (p. 255).

Mr. Stewart:—Pharynx of snail.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. William A. Delferier, Wilson Noble, and Charles N. Peal.

Walter W. Reeves,
Assist.-Secretary.

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

Ser. II. Vol. II. Part 3. | JUNE, 1882. | To Non-Fellows, Price 4s.

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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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

Ser. 2.—Vol. II. Part 3.

(JUNE, 1882.)

CONTENTS.

Summary of Current Researches, &c.—*continued.*

Botany.

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

Royal Microscopical Society.

MEETINGS FOR 1882,

AT 8 P.M.

1882.	Wednesday,	JANUARY	11
	„	FEBRUARY .. .. (*Annual Meeting for Election of Officers and Council.*)	8
	„	MARCH	8
	„	APRIL	12
	„	MAY	10
	„	JUNE	14
	„	OCTOBER	11
	„	NOVEMBER	8
	„	DECEMBER	13

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.

COUNCIL.

ELECTED 8th FEBRUARY, 1882.

PRESIDENT.

Prof. P. Martin Duncan, M.B., F.R.S.

VICE-PRESIDENTS.

Prof. F. M. Balfour, M.A., F.R.S.
Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.
Robert Hudson, Esq., F.R.S., F.L.S.
John Ware Stephenson, Esq., F.R.A.S.

TREASURER.

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

SECRETARIES.

Charles Stewart, Esq., M.R.C.S., F.L.S.
Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.

Twelve other MEMBERS of COUNCIL.

Ludwig Dreyfus, Esq.
Charles James Fox, Esq.
James Glaisher, Esq., F.R.S., F.R.A.S.
J. William Groves, Esq.
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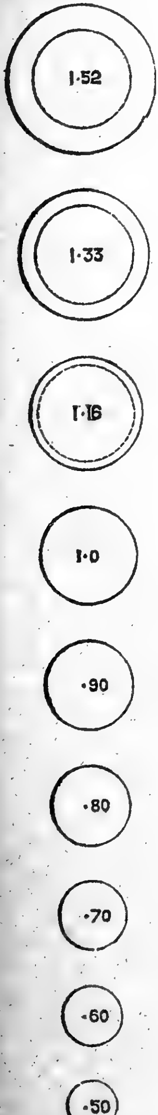
T. Charters White, Esq., M.R.C.S., F.L.S.

I. Numerical Aperture Table.

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

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

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

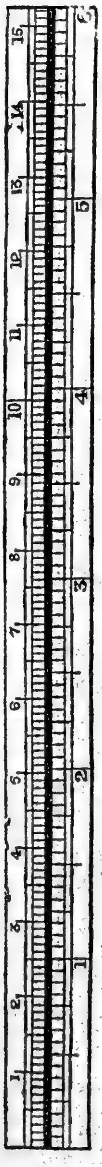
EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows:—106° (air), 157° (air), 142° (water), 130° (oil).
Their actual apertures are, however, as ·80 ·98 1·26 1·38 or their numerical apertures.

II. Conversion of British and Metric Measures.

(1.) Lineal

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

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., int[o] Micromillimetre[s], &c.

ins.	μ
1/25000	1·01599
1/20000	1·26998
1/15000	1·6933
1/10000	2·5399
1/9000	2·82219
1/8000	3·1749
1/7000	3·6285
1/6000	4·2332
1/5000	5·0799
1/4000	6·3499
1/3000	8·46659
1/2000	12·69988
1/1000	25·39977
	mm.
1/900	·02822
1/800	·03175
1/700	·03628
1/600	·04233
1/500	·05080
1/450	·05644
1/400	·06349
1/350	·07257
1/300	·08466
1/250	·10159
1/200	·12699
1/150	·16933
1/100	·25399
1/50	·50799
1/25	1·01599
1/20	1·26998
1/16	1·58748
1/15	1·69331
1/12	2·11664
1/10	2·53997
1/8	3·17497
1/6	4·23329
3/16	4·762457
1/5	5·07995
1/4	6·34994
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

(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
	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.								
		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.	1⅓ in.	1 in.	⅘ in.	⅔ in.	½ in.	4/10 in.	⅓ in.	¼ in.
		MAGNIFYING POWER.								
FOCAL LENGTH.	MAGNIFYING POWER.	5	7½	10	12½	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	2½	12½	18¾	25	31¼	37½	50	62½	75	100
3	3⅓	16⅔	25	33⅓	41⅔	50	66⅔	83⅓	100	133⅓
2	5	25	37½	50	62½	75	100	125	150	200
1½	6⅔	33⅓	50	66⅔	83⅓	100	133⅓	166⅔	200	266⅔
1	10	50	75	100	125	150	200	250	300	400
8/10	12½	62½	93¾	125	156¼	187½	250	312½	375	500
¾	13⅓	66⅔	100	133⅓	166⅔	200	266⅔	333⅓	400	533⅓
⅔	15	75	112½	150	187½	225	300	375	450	600
½	20	100	150	200	250	300	400	500	600	800
4/10	25	125	187½	250	312½	375	500	625	750	1000
⅓	30	150	225	300	375	450	600	750	900	1200
3/10	33⅓	166⅔	250	333⅓	416⅔	500	666⅔	833⅓	1000	1333⅓
¼	40	200	300	400	500	600	800	1000	1200	1600
⅕	50	250	375	500	625	750	1000	1250	1500	2000
⅙	60	300	450	600	750	900	1200	1500	1800	2400
1/7	70	350	525	700	875	1050	1400	1750	2100	2800
⅛	80	400	600	800	1000	1200	1600	2000	2400	3200
1/9	90	450	675	900	1125	1350	1800	2250	2700	3600
1/10	100	500	750	1000	1250	1500	2000	2500	3000	4000
1/11	110	550	825	1100	1375	1650	2200	2750	3300	4400
1/12	120	600	900	1200	1500	1800	2400	3000	3600	4800
1/13	130	650	975	1300	1625	1950	2600	3250	3900	5200
1/14	140	700	1050	1400	1750	2100	2800	3500	4200	5600
1/15	150	750	1125	1500	1875	2250	3000	3750	4500	6000
1/16	160	800	1200	1600	2000	2400	3200	4000	4800	6400
1/17	170	850	1275	1700	2125	2550	3400	4250	5100	6800
1/18	180	900	1350	1800	2250	2700	3600	4500	5400	7200
1/19	190	950	1425	1900	2375	2850	3800	4750	5700	7600
1/20	200	1000	1500	2000	2500	3000	4000	5000	6000	8000
1/25	250	1250	1875	2500	3125	3750	5000	6250	7500	10000
1/30	300	1500	2250	3000	3750	4500	6000	7500	9000	12000
1/40	400	2000	3000	4000	5000	6000	8000	10000	12000	16000
1/50	500	2500	3750	5000	6250	7500	10000	12500	15000	20000
1/60	600	3000	4500	6000	7500	9000	12000	15000	18000	24000
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 1/75 less and 1/15 more than the figures given in this column.

Spicules of Regular Echinoids

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TRANSACTIONS OF THE SOCIETY.

VII.—*Note on the Spicules found in the Ambulacral Tubes of the regular Echinoidea.* By Professor F. Jeffrey Bell, M.A., F.R.M.S.

(*Read 10th May*, 1882.)

Plate V.

I have thought that it might be of interest to the Society to have some further information on the distribution of the spicules found in the ambulacral tubes of the regular Echinoidea. The greater part of our present knowledge on this subject we owe to the researches of one of our Secretaries, Mr. Charles Stewart, the most important of whose papers was published in the Linnean Society's 'Transactions' for 1865.* I have been enabled to examine a large series of genera and species, and as my leading object has been to find some further characters which would be of assistance in the classification of the groups and genera of the order, I have confined my attention at present to the sucking-tubes.

Commencing with the genus *Echinus*, I was struck by the constant presence in its species of those C-shaped or bihamate spicules, the characters of which will be known to every microscopist (Pl. V. Fig. 1). Carrying on these researches further, I

EXPLANATION OF PLATE V.

Fig. 1.—*Echinus* (*E. margaritaceus*), to show the ordinary bihamate spicules.
" 2.—*Coitaldia* (*C. forbesiana*).
" 3.—*Echinocidaris* (*E. dufresnii*).
" 4.—*Echinothrix* (*E. turcarum*).
" 5.—*Diadema* (*D. setosum*).
" 6.—*Micropyga tuberculata*.
" 7.—*Asthenosoma pellucidum*.
" 8.—*Phormosoma bursarium*.
" 9.—*Salenia hastigera*.

* Vol. xxv. p. 365.

found that every genus of the so-called Triplechinidæ which I examined contained these same bodies; similarly they were to be found in the other division (Temnopleuridæ) of the Echinidæ, as limited by Professor Alexander Agassiz. Nor were they here only; when the suckers of the Echinometridæ were examined, the bihamate spicules were again to be observed. In the Cidaridæ, Salenidæ, Echinothuridæ, Echinocidaridæ, and Diadematidæ, the bihamate spicules were, on the other hand, conspicuous by their absence; and this being so, I found in their distribution among various genera of the Echinometridæ and Echinidæ a gratifying support to the view on which I have elsewhere † insisted, that these two groups differ less from one another than they do from any other group of the regular Echinoids. It may be worth while to give the names of the genera examined :—*Heterocentrotus, Colobocentrotus, Echinometra, Echinostrephus,* * *Strongylocentrotus, Sphærechinus,* * *Pseudoboletia,* * *Temnopleurus, Salmacis, Mespilia, Amblypneustes,* * *Microcyphus,* * *Cottaldia,* * *Echinus, Tripneustes, Toxopneustes,* * *Evechinus.* *

The number of genera examined is now sufficiently large to justify us in the belief that C-shaped spicules will always be found in the suckers of the Echinidæ, as I have proposed to define the term.

With regard to the form here called *Cottaldia*, it may be added that the specimen was collected by the 'Challenger,' and that, therefore, it was determined by Prof. Alex. Agassiz; a reference to that naturalist's report will sufficiently prove that he has had considerable difficulty in finding a place for the species; that difficulty cannot, however, extend to its general position, now that the spicules have been examined, and been found to be of the bihamate type (Fig. 2).

With regard to the Diadematidæ, we have to note that, if the forms have been correctly united, there is not the same closeness in the characters of the ambulacral spicules in this group as there is in that of the Echinidæ; though we can imagine a connection between the spicules of *Echinothrix* (Fig. 4), and those of *Diadema* (Fig. 5) it hardly seems possible to associate with them those of *Micropyga* (Fig. 7) or of *Astropyga*, which have so striking a Holothurian facies, and no generalization can safely be made at present for this division.

When Mr. Stewart published his paper in 1865 he had been unable to find spicules in the ambulacral tubes of *Echinocidaris* (*Arbacia*). I, too, was for a time unable to find them, but at last they were detected; they are but scantily present, but are very characteristic, being greatly widened in the middle, and frequently

† Proc. Zool. Soc. Lond., 1881, p. 418.
* Those marked with an asterisk were not reported on by Mr. Stewart.

perforated in that portion (Fig. 3). It would seem likely that the rarity of these spicules may be ascribed to the great thickness of the walls of the suckers, the development of muscular and connective tissue being so considerable that there is no such necessity for the spicules here as there is in cases where the walls are thinner; but the spicules themselves are proportionately large.

The bihamate spicules of the Echinidæ, the tri-radiate ones of *Diadema*, the flattened centrally enlarged form of *Echinocidaris*, present little in common, and, while there would be no difficulty in distinguishing them, it is likewise impossible at present to make a suggestion as to how they might be derived from one another. When with these we compare the ambulacral spicules of *Salenia* it is not perphaps too hardy to suggest that in the irregular forms there to be found we may have something hardly more than "amorphous," from which the forms of the later groups have been derived.

There is no close resemblance between the spicules of *Cidaris* * and those of *Phormosoma* and *Asthenosoma* (Figs. 8 and 9); the reticular character of the spicules of the Echinothuridæ is doubtless to be associated with the comparative tenuity of their tests.

* See Stewart, Quart. Journ. Micr. Sci. xi. (1871) pl. iv.

VIII.—*The Relation of Aperture and Power in the Microscope.**

By Professor Abbe, Hon. F.R.M.S.

(*Read* 10*th May*, 1882.)

I.—*General Considerations as to Wide and Narrow Apertures.*

The question of the relative values of high and low apertures has been much obscured by the one-sidedness with which it has been treated. One party of microscopists—the "wide-aperturists"—having recognized that high apertures are capable of exhibiting minuter details than low apertures, conclude therefrom that *all* microscopical work must be done with very wide apertures, and that low-angled systems are worthless. Another party, relying upon the fact that there are many cases in which low or moderate apertures perform decidedly better than wide ones, generalize this experience and deny that there can be any essential benefit in very wide apertures, asserting that all observations, with the possible exception of resolving diatom striæ, can be done as well with low-angled objectives. The premises of both these views may be said to be true, but true *under conditions* only; and by disregarding these conditions both parties arrive at conclusions which are equally remote from a proper estimation of the requirements of scientific work with the Microscope. My view of the question † is based on the following considerations:—

1. Every given degree of minuteness of microscopic detail requires a given aperture in order to obtain a complete (or perfect) image, i. e. an image which is a *true* enlarged projection of the structure, exhibiting all elements in their true form and arrangement. The minuter the dimensions of the elements the wider an aperture is *necessary*—the larger these dimensions the narrower an aperture is *sufficient*. Structures whose smallest elements are measured by considerable multiples of the wave-lengths of light are perfectly delineated with low or very moderate apertures, and their examination with wide apertures does not improve their recognition. On the other hand, if we are dealing with objects whose dimensions (or structural elements) are equal to a few wave-lengths only, even the

* The paper (received 8th April) is written by Professor Abbe in English.

† As some suggestion appears to have been made when the above paper was read as to my views having undergone a change, I beg to remind my readers that the views above explained are those which I have professed since 1873—the date of my first paper on the subject. My advocacy of wide apertures for *minute* objects appears to have been interpreted as an advocacy of wide apertures for all purposes—a misapprehension which I am at a loss to account for, as nothing I have ever said or written could justify any such a supposition.

All the catalogues of Mr. Zeiss issued since 1872 give practical evidence of this, as the objectives there specified (and stated to be constructed according to my principles and under my direction) include no low and medium powers, *except with low or very moderate apertures.*—E. A.

widest apertures hitherto obtained will not afford complete or strictly true images, but will show these objects more or less incomplete or modified. This general principle holds good in regard to objects of every kind, regular or irregular, isolated particles or composite structures, because the physical conditions of microscopical delineation are always the same.

The obvious inference from this principle 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.

It may perhaps be said that the objects of microscopical research do not justify such a distinction of large and minute, since the works of nature are always elaborated to the minutest details, all coarse objects being composed of smaller elements, and these of still smaller ones, &c. This is quite true in regard to the objects considered as natural things, but not as objects of scientific research. The interest of research is not always directed to the ultimate elements, but is as often confined to the consideration of the coarser parts, and in such cases the observer is not only allowed but sometimes compelled, to disregard everything which is not connected with the scientific aim of his investigation. To observe every object in nature throughout, from alpha to omega, is the privilege of dilettante microscopy only, which has no distinct aim. There are many lines of the most valuable scientific research (e. g. the greatest part of all morphological investigations) which have not to deal with very minute things. This kind of work can be completely done with low or moderate apertures.

To recommend the application of wide-angled objectives for every branch of microscopy, as has been, in fact, done by excited wide-aperturists, is no more to be supported than it would be to recommend the use of a magnifier to a painter for inspecting the tree which he proposes to delineate.

According to what has just been said, the only benefit of greater aperture is that it is capable of delineating *minuter* things. Now minute dimensions require high amplifications in order that they may be enlarged to a visual angle sufficient for distinct vision. Low figures of amplification cannot render visible (at least not distinctly visible) details which are beyond a certain limit of minuteness. Even if they are delineated by the Microscope they would remain hidden to the eye for want of sufficient visual angle. It follows therefore that wide apertures will not be utilized unless at the same time there is a linear amplification of the image, at least sufficient for exhibiting to the eye the smallest dimensions which are within the reach of such an aperture. On the other hand, a high amplification will be useless if we have small apertures which delineate details of dimensions only capable of being distinctly seen in an image of much lower amplification. We have here an empty amplification, because there is nothing in the image which requires so much power for distinct recognition. In the first case (deficiency of power) the large aperture cannot show more than a smaller one; in the other case (deficiency of aperture), the high amplification shows no more than a lower would do. Consequently:—

Wide apertures when high amplification is required; low or moderate apertures when low or moderate amplifications are sufficient or cannot be overstepped.

2. The utilization of a given aperture depends in principle on the amplification of the *ultimate* image which is projected by the entire Microscope to the observer's eye. Now one and the same amplification may be obtained in very different ways since it is the resultant of three distinct elements, (*a*) focal length of the objective, (*b*) focal length of the ocular, and (*c*) length of the tube. Any definite number of diameters (say 1000) can be obtained with a low power objective (say a 1-inch) as well, from a mere dioptrical point of view, as with a higher power (say $\frac{1}{8}$-inch), by applying a sufficiently deep eye-piece and a sufficient length of the tube. It is, however, well known that there is a great difference in the optical qualities of images which are produced under these different conditions. Forcing a high amplification from a low-power objective is always connected with a considerable loss of sharpness of definition of the image, owing to the magnification of the residuary aberrations, which are inherent even in the most finished constructions. It is, therefore, a well-established practical rule that a certain amount of amplification requires a certain power of the *objective*—higher amplification a higher power (shorter focal length)—in order to obtain the image under those favourable conditions which are necessary for their full effectiveness. This considered, the inference of the foregoing paragraph may be expressed in these terms:—

Wide apertures with objectives of short focal length; low and moderate apertures with objectives of low and moderate power.

As a detailed discussion of this subject will be found in the second part of this paper, it will be sufficient here to point out some notable facts of experience by way of example only.

With objectives of say 1 inch, and $\frac{1}{2}$ inch, focal length, the lower and medium eye-pieces in use will yield 40–80 and 80–160 diameters only. In order to obtain 150 and 300 respectively, very deep oculars (or an extra length of the tube) would be required. So far now as such objectives are intended for the lower powers mentioned above, an aperture of about 0·15 (18°) in the case of the 1-inch, and of 0·3 (35°) in the case of the $\frac{1}{2}$-inch, are at all events more than sufficient for showing every detail which can possibly be recognized by the eye under these amplifications, and therefore wider apertures are useless. In point of fact, no observer will see anything more or anything better with similar objectives of say 0·40 (48°) and 0·75 (96°) respectively, than with the narrower angles indicated above, as long as the low and medium oculars are in question only. These latter apertures would require for their full utilization, i. e. for convenient observation of the minuter details which are within their reach, amplifications of much more than 150 and 300 diameters. With well-made objectives of those apertures, such figures may be realized indeed, and details may be shown by means of deeper eye-pieces, which remain quite invisible with the lower angled systems; but no microscopist can deny the inferior quality of the images obtained in this way if compared to those of equal amplification, which are obtained with these same apertures when the objectives have double the power and the oculars the half only. Structures of so simple a composition as diatom striæ may perhaps be tolerably displayed under such forced amplifications of low-power objectives, but with objects of somewhat irregular and complicated structure the deterioration of the image attendant upon a considerable enlargement of the residuary spherical and chromatic aberrations by deep eye-pieces, becomes at once obvious even with the most finished objectives. In point of fact, no experienced histologist will ever use in ordinary work even an ocular amplification of the amount necessary for obtaining 100 diameters from a 1-inch objective or 200 from a $\frac{1}{2}$-inch. He would be unwise if he troubled himself with inferior images whilst good images of the amplifications required could be obtained with equal, or even greater, convenience with objectives of the same apertures but half the focal length.

The above is an example of waste of aperture, or lack of useful power; waste of power and lack of aperture are exemplified by every objective of excessively short focal length, e. g. $\frac{1}{50}$ inch. Such a lens, even if immersion, cannot be made with an aperture of much greater numerical value than 1·0, in consequence of the technical obstacles arising with such very short focal lengths. Now the limit of an aperture of that amount is entirely exhausted, at all events with a power of 1000 to 1200 diameters, inasmuch as nothing of the real attributes of an object can be seen with that aperture under a higher amplification, which could not be as well recognized under the lower. A $\frac{1}{50}$, however, will yield 1500–2000 diameters with the lowest eye-pieces which are usually employed. The lowest attainable power is therefore an empty power already, and every useful amplification available with the aperture in question could be obtained under favourable conditions and with much less inconvenience by an objective of half the power, or even less.

3. The preceding shows that wide apertures can only be utilized in the observation of minute details, under high amplifications obtained with objectives of short focal length. Wide apertures are therefore useless when those conditions are not fulfilled, because in this case the same result could be obtained as well with low-angled systems. But as abundance *primâ facie* is no detriment, the foregoing considerations do not enforce any positive objection to the use of wide apertures for every kind of work. There are however other points of view from which it becomes obvious that the application of wider apertures than can be utilized is not merely superfluous but is a decided disadvantage, inasmuch as they prevent the utilization of some really valuable benefits which are the privilege of low and moderate apertures.

The first disadvantage results from the reduction of the depth of vision (or the "penetration" of the Microscope) which is connected with wide apertures. I have given in another place* a discussion of the circumstances on which penetration depends, and the formulæ which afford an approximate numerical estimation of the depth of vision in microscopic observation. These theoretical suggestions show (in accordance with the experience of practical microscopists) the reduction of penetration with increasing aperture under one and the same amplification, and especially when the amplification is not restricted to very small figures. Now there are many objects of microscopical research which do not require, and, indeed, do not even admit of high powers, but demand for effective investigation as much penetration as possible. This is always the case where the recognition of *solid* forms is of importance, and therefore a distinct (at least, a tolerably distinct) vision of different planes at once must be possible, whether the observation is assisted by stereoscopic devices or not. The greater part of all morphological work is of such a kind, and in this line of observation therefore a proper economy of aperture is of equal importance with economy of power.

Whenever the depth of the object under observation is not very restricted, and it is essential that the depth dimension shall be within the reach of direct observation, low and moderate powers cannot be overstepped, and no greater aperture should therefore be used than is required for the effectiveness of these powers—an excess in such a case is a real damage. High powers and correspondingly wide apertures are restricted to those observations which do not require any perceptible depth of vision, i. e. to two different cases (1) when the objects are quite flat or exceedingly thin; (2) when preparations of greater depth are sufficiently transparent to admit of an *indirect* recognition of their solid structure

* See this Journal, i. (1881) p. 689.

by means of successive optical sections through *successive* focussing of different planes. For the latter method of observation the loss of penetration with increasing power and aperture is no drawback, but rather an advantage, because it enhances the distinct separation of the sectional images at successive foci. A disregard of these natural restrictions in the use of wide apertures is obviously the origin of the opinion that aperture *per se* is antagonistic to good definition. It is quite true that there are many even very delicate objects which are much better seen under a given amplification with a system of very moderate than with one of very wide aperture, the former giving a clear view of the whole structure, the latter showing perhaps some distinct points, but as a whole veiled in haze. Provided, of course, that we have well-corrected objectives, the fault here is not on the part of the lens, but on the side of the object, which requires for proper recognition a greater range of depth than is reconcilable with a wide aperture. The theoretical suggestion which has been brought forward in support of the notion that different parts of the clear area of an objective produce *dissimilar* images, and that *therefore* the resultant image must show increasing confusion with increasing aperture, cannot apply to the delineation of a plane object. In a well-corrected objective the partial pictures received through the various parts of the aperture-area are always strictly similar so far as one plane of the object is concerned. The confusion suggested is nothing else but confusion of the images of *different depths*—lack of penetration, but not lack of "definition" in any reasonable sense of that term. Provided the objectives are properly corrected and the objects are fit for the delineation of an image, undisturbed by interfering confused images from other planes, the "defining power" of an objective is always greater with greater aperture for every kind of objects, inasmuch as under all circumstances the wider aperture admits of the utilization of higher amplifications than can be obtained without perceptible loss of sharpness (with the same objects) by lower apertures.

There is therefore no drawback in principle to the use of a large aperture when the objects are suitable. But the considerations above lead to the conclusion:—

> *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.*

4. There is still another point of view, and one of special practical importance, which shows the positive damage connected with the use of *unnecessarily* wide apertures. The increase of

aperture is prejudicial to the ease and convenience of microscopical work in two essential respects.

1stly, It necessitates a progressive reduction of the working distance of the objective. Owing to the rapid increase of the anterior aberration with increasing obliquity of the marginal rays (particularly in the case of dry lenses), perfect correction of a system cannot be obtained unless the layer of low refraction between the object and the front lens (i. e. the working distance) is reduced to a certain fraction of the focal length of the system, which fraction is necessarily diminished in a rapid proportion as the aperture becomes greater and greater. Whilst there is no objection to retaining as working distance $\frac{7}{10}$ of the focal length for an aperture of 30°, if the aperture is 60° not more than $\frac{3}{10}$ can be allowed, and with an aperture of 116° really good correction is not reconcilable with a working distance exceeding $\frac{1}{10}$ of the focal length. It is therefore an obvious disadvantage to use aperture angles of 60° and of 116°, when the power which is required or available can be obtained with 30° and 60° respectively.

2ndly, 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, 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 of wide aperture, in particular with the dry system. An objective of a few degrees is almost insensible, it may be focussed to 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 always 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.*

So far as the necessity of obtaining a certain amount of amplification in an efficacious manner *requires* a certain aperture, the above-mentioned restrictions and difficulties in the proper management of the objectives cannot be avoided. But all restrictions in regard to the objects, and all the trouble taken in the adjustment of the objectives, is quite for nothing when the same result can be obtained with a lower aperture. If for the sake of convenience the precautions required in the use of wide-angled lenses should be disregarded in working with the lower powers of wide aperture, the performance of such lenses is always *worse* than that of much narrower apertures under the same amplification. 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 alone (even under the imperfect state of correction) is disturbed by the coarse dissipation of light from the ineffective marginal parts of the aperture.

The amateur who likes the Microscope for his amusement may not much object to some extra trouble connected with the use of

* The reduction of this sensibility in somewhat large apertures is one of the great practical advantages of the immersion-method. The extreme increase of that sensibility which is met with when the aperture of *dry* lenses approaches the maximal value of *a* for air (1 N.A.), is in my opinion a strong objection to the construction of such lenses with greater apertures than 0·80–0·85. Not only in this case must the working distance be reduced to an intolerably small amount in order to obtain proper correction, but the preservation of that correction in the practical use of the systems is almost impossible, notwithstanding the correction-collar, whilst at all events the very slight benefit of optical performance is not worth speaking of in comparison to the large increase obtained with the immersion-method under so much more favourable conditions.

I need scarcely point out here that the claim of a *special* insensibility of certain lenses in regard to differences of the cover-glass (as has been sometimes made) is, to say the least, either great thoughtlessness or simple self-delusion, just as are similar claims of *special* penetration in favour of certain objectives. The aberrations in question, as well as the dissipation-circles from difference of focus, originate *outside* the Microscope. The particular construction of the objective cannot possibly therefore influence their amount in a cone of rays of given aperture, and the degree in which both become *visible* in the ultimate image of the Microscope must be strictly determined by the same elements which determine the visibility of any real object of given dimensions at the same plane of focus. There is no room left, therefore, for special properties of different constructions.

It is, however, true that an *apparent* insensibility, as well as an apparent depth of focus, is sometimes found, viz. in *badly* corrected objectives. When a system has no distinct focus at all, it is quite evident that the dissipation-circles arising from different thicknesses of the cover-glass, and from the difference of focus of different levels, may become much greater before the deterioration of the indistinct image becomes visible. Well-corrected objectives *must* be sensitive in both respects in strict accordance with their aperture so far as one and the same system of construction (dry or immersion) is in question.

wide-angled low-power lenses, which he admires as brilliant specimens of optical art. For those, however, who *work* with the Microscope, the economy of labour to which they are obliged will be expressed by the rule:—

> *Never use wider apertures than are necessary for the effectiveness of the power, because excess of aperture is always waste of time and labour.*

5. A few remarks about another point of practical interest. By those who plead in favour of large apertures *in all cases*, it has been sometimes suggested as a rational plan for reconciling opposite demands, to have all objectives constructed with relatively wide angles, and to reduce them by stops or diaphragms when smaller angles are desired. 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. It is not merely that the stops cannot increase the working distance (which will always remain at the point corresponding to the full aperture of the lens), but that 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. The reason will be readily understood from the following consideration.

The best correction of an objective of given aperture depends on the proper *distribution* of a certain amount of residuary aberration, which cannot be eliminated with our present means. The greater the aperture the more aberration must be intentionally left *at the central part of the system* in order to prevent an obnoxious accumulation in the marginal zone. It is obvious, therefore, that with an aperture-angle of say 90° the inmost cone of 45° cannot be so well corrected as it might be if the marginal zone could be left out of account. The effect is by no means inconsiderable, particularly in regard to the colour corrections. Owing to the chromatic difference of the spherical aberration the central portion of a somewhat wide aperture must always, even in a well-arranged objective, be perceptibly under-corrected chromatically, and in using this central part alone (the compensating influence of the over-corrected marginal zone being done away with), we have the performance of an inferior lens. In point of fact, no intelligent optician would ever make an objective of 30° aperture on the same formula as one of 60°, or one of 60° on the same formula as another of 100°, though this could be done by merely reducing the clear diameter of the lenses.

There cannot, therefore, be a reconciliation between the pleasure of exhibiting mere optical accomplishment and the interests of the working microscopist. Bad lenses will certainly not meet the demand for low and medium powers affording the utmost possible economy of time and labour in scientific work. This can be done only by systems in which all advantages attendant upon the lower apertures are fully realized by constructions specially aiming at the *best* which can be obtained under the actual conditions of the case.

The *progressive increase of aperture in the higher powers*, formerly within the capabilities of the dry system, and at a later period by the development of the immersion method, is, without any reasonable doubt, the most important feature of the *modern advance of microscopical optics.* It has rendered possible the successful extension of microscopical research to minuter and minuter objects, which otherwise would have been impossible by the ineffectiveness of all increase of amplification beyond certain low figures. The appreciation of that progress and the recognition of its true basis has led to a tendency to increase more and more the aperture of *every* kind of objectives. The fact has been disregarded that it is an entirely different thing whether the object is to promote the performance of the Microscope *in the whole* at the limits of its power, or to promote its performance for aims beyond these limits. The opinion has thus arisen that what is a benefit for one kind of lenses must also be a benefit for every other kind. Objectives of low and medium powers (1-inch to $\frac{1}{4}$-inch) of 15° to 60° are proclaimed at this time by many microscopists as old-fashioned and worthless things; 45° to 100°, or even 60° to 140°, are wanted for the same powers. Now as from a purely technical point of view, it *is* an accomplishment when the delineating power of an objective cannot be exhausted even with the deepest eye-pieces, opticians (notwithstanding the total bootlessness of such a superabundance) of course take pleasure in making such "superior" lenses, and the natural consequence is that the lower apertures required for useful scientific research are likely to be esteemed as second-rate work, no longer worthy of high technical art.

This opinion is a fatal mistake, and its practical effect, if not counteracted, will be a decided retrogradation of microscopical optics. Nobody, of course, can have the least objection to the construction of lenses of any descripition whatever for the personal pleasure of this or that microscopist. Strong opposition should, however, be made against all tendencies of captivating microscopical optics, in favour of such predilections, at the cost of the general usefulness of the instrument.

> *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.*

IX.—*The Bacteria of Davaine's Septicæmia.*

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

(*Read* 10*th May*, 1882.)

The organisms here shown under the Microscope, and which occur in the blood of the rabbit, in the form of septicæmia known as that of Davaine (one of the first who described it, about twenty years ago), are remarkable, in many respects, from a microscopical point of view, and possess a general interest from their relation to the affection in which they occur, and which has been regarded almost as the type of a specific parasitical disease, from the circumstance that the blood of an animal in these cases is infective in inconceivably small quantities. The statements of Davaine on this point, which attracted so much attention, were that the trillionth,* or the ten-trillionth part of a drop of this blood was infective.

His experiments were repeated by several observers, who confirmed his results in different degrees. I have myself found, in numerous experiments, that in the case of rabbits the blood is usually infective up to the millionth and the hundred-millionth part of a drop; sometimes in even smaller quantities, obtained by successive dilutions.

In such blood I have found that the organisms here described always occur, but in very variable numbers; in some cases not more than one or two are to be found in each field of view, in others they exceed many times the number of the blood-corpuscles; they do not appear to increase in any marked manner shortly after death, as is the case in some other affections. The microphyte itself is a form of *Bacterium*, in the generic sense of the term, as defined by Cohn; its diameter, which varies less than that of any other form of Schizophyte which I have examined, is just over half a micromillimetre ($0 \cdot 509\ \mu$), almost exactly $\frac{1}{50000}$ m. The length which, in different stages of development, is very variable, may be put down at from $1\frac{1}{2}$ to 2, 3, or, in a few cases, 5 times the diameter, that is, of the single cells, or rods as they are commonly termed; two or three of these, but not more, sometimes occur united together, endwise, forming short chains; but they never, in the blood of an animal, form either long leptothrix filaments or zoogloea masses. They frequently appear in the form of a figure of 8, or a dumbbell; this, as is shown in stained preparations—an example of which may be seen in the field of view under the Microscope—is not due to a constriction of the cell-wall, indicating incipient fission, but to a difference in its constituent parts and their refractive power; the

* A trillion in the French notation is a billion in the English, i. e. a million squared.

two ends are the most highly refracting, they take the staining more deeply than the intermediate portion, which is often with difficulty perceptible; the ends thus stained present the appearance of forming spores, in some cases so distinctly that I am disposed to think this is really the case, though I have never witnessed their complete development.

The preparation shown is from the blood of a rabbit of the third generation of artificial infection, it was made very shortly after death, and treated by the methods introduced by Weigert and Koch, which have been described elsewhere, and are now pretty generally known and adopted. I have not found these Bacteria in any of the organs or the tissues, excepting the blood and the lymph of an infected animal, examined immediately after death, not even in the lungs or the spleen, where, judging from other cases, we should expect to meet with them; their minute size, however, and more especially their not readily staining, would render them very difficult to distinguish in the tissues. In the blood this *Bacterium* is evidently motile, sometimes very actively so.

Notwithstanding the interest and attention which this affection has excited during several years, and the importance of the microphyte in relation to the question of the true nature of the contagium, it has not, I believe, been figured or at all carefully described by any one, excepting only by Coze and Feltz, in a work published at Strasbourg and Paris several years ago; their description is imperfect, and does not in any way coincide with my own observations; they even give the diameter of the organism just three times as great as I have found it. These measurements I have checked by the use of the admirable standard stage micrometer recently constructed by Professor Rogers, of Cambridge, U.S.A., one of which I have received, and which is most valuable in enabling different observers to compare exactly their measurements. The immense discrepancy, however, between my observations and those of Coze and Feltz, cannot be reconciled by any variations in the standard scale used, and renders it difficult to believe that the same organism has been observed in the two cases. This opens up a very important, indeed a fundamental question with reference to the etiology of this affection, which need not be discussed here; I will only say that in the course of very numerous experiments, in different series, I have found the organism specifically distinct, invariable and constant in all cases, thereby conforming to the first and most important condition which has been laid down as a test for a specific parasitical contagium.

In relation to the dimensions of the organism, and the infective virulence of the blood in which they are contained, a very curious question arises as to how many Bacteria or their germs can be contained in a given quantity of blood, and this, as far as I know, has never been yet considered or referred to. Taking the dimensions of the Bacteria to be, diameter 0·5 μ, which is a fraction less than the actual measurement, and the length to be 2 diameters, which is undoubtedly under the average, a very simple calculation shows that in a drop, taken as the 16th part of a cubic centimetre, there would be 250,000,000,000 (two hundred and fifty thousand million), or just a quarter of a billion; this would be when the blood was entirely filled with, or rather replaced by a solid mass of Bacteria, leaving no space at all for the blood-corpuscles and but little for the plasma; and this is the utmost number which a drop could contain. I think it is evident, therefore, that there is some fundamental error in Davaine's statement and in that of those who have followed him, on this point. I have endeavoured directly to enumerate the number of Bacteria present in different portions of blood, but I cannot pretend to have succeeded with even approximate accuracy; the greatest number I could enumerate or estimate was a few millions in a drop.

Another point of special interest in this affection is the asserted increase in the infective virulence of septicæmic blood in successive generations of transmitted infection. This theory was explicitly maintained by Coze and Feltz, but Davaine's statements on the subject have been somewhat misunderstood, for although he asserted this in the fullest extent at first, he ultimately qualified the statement in some measure by showing that the maximum of virulence is reached very early; subsequent observers overlooked this qualification, and repeated and even improved upon Davaine's original statements. This question has again lately attracted attention in connection with the relation of micro-organisms to disease, and the sensational and, were they to be credited, appalling statements that have been made, and even supported, by high authority, asserting a transformation of physiological species in some of the lower organisms, which hypothesis, it was supposed, might be connected with or account for an increase in infective virulence in the organisms present in septicæmic blood in successive generations. On this point I shall only say that I have found in a long series of experiments recently made, that although the infectivity of such blood may be slightly variable, there is no such thing as progressive increase of virulence in successive generations; the blood of the first generation is actively infective in the millionth or the 100-millionth of a drop, or less, and it is not, and indeed for the reasons already stated, cannot be infective in very much smaller quantities, in the 25th nor any succeeding generations, nor is there any shortening of the incubation period, which in the large majority of cases is remarkably constant, ranging from twenty-one to twenty-four hours.

The relation of the organisms here described to the disease in which they occur, has recently been the subject of experiment in Germany; I shall only say with regard to this that on investigating this question, it appears to me clear that the *Bacterium* does constitute the specific virus, the actual contagium of the affection.

The importance of the relations of these microphytes to disease, and indeed their rôle in the whole economy of nature is now so generally acknowledged that it is unnecessary to dwell upon it. It is only quite recently that the subject has been systematically developed, and already most valuable results have been attained, some of which, in regard to a most important practical application, viz. to tubercular disease, have only been communicated during the last month, and demonstrated in this College in the present week. It is by the microscopical examination of the organisms and the determination of their specific morphological characters alone, that many of the most weighty questions which present themselves can be determined. There is no field of microscopical research which requires more care or better optical appliances than these organisms, and none more worthy the attention of microscopists.

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.

Germinal Layers of the Chick.†—Professor F. M. Balfour and Mr. F. Deighton record the results of a renewed study of two much disputed points in the ontogeny of birds, viz. the origin of the mesoblast and the origin of the notochord.

1. With reference to the first of these, their results are briefly as follows:—

The first part of the mesoblast to be formed is that which arises in connection with the primitive streak. This part is in the main formed by a proliferation from an axial strip of the epiblast along the line of the primitive streak, but in part from a simultaneous differentiation of hypoblast cells also along the axial line of the primitive streak. The two parts of the mesoblast so formed become subsequently undistinguishable. The second part of the mesoblast so formed is that which gives rise to the lateral plates of mesoblast of the head and trunk of the embryo. This part appears as two plates—one on each side of the middle line—which arise by direct differentiation from the hypoblast in front of the primitive streak. They are continuous behind with the lateral wings of mesoblast which grow out from the primitive streak, and on their inner side are also at first continuous with the cells which form the notochord.

In addition to the parts of mesoblast, formed as just described, the mesoblast of the vascular area is in a large measure developed by a direct formation of cells round the nuclei of the germinal wall.

The mesoblast formed in connection with the primitive streak

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

† Quart. Journ. Micr. Sci., xxii. (1882) pp. 176–88 (3 pls.).

gives rise in part to the mesoblast of the allantois, and ventral part of the tail of the embryo, and in part to the vascular structures found in the area pellucida.

With reference to the formation of the mesoblast of the primitive streak, the authors' conclusions are practically in harmony with those of Koller; except that Koller is inclined to minimize the share taken by the hypoblast in the formation of the mesoblast of the primitive streak.

Gerlach, with reference to the formation of this part of the mesoblast, adopts the now generally accepted view of Kölliker, according to which the whole of the mesoblast of the primitive streak is derived from the epiblast.

As to the derivation of the lateral plates of mesoblast of the trunk from the hypoblast of the anterior part of the primitive streak, the authors' general result is in complete harmony with Gerlach's results, although in their accounts of the details of the process they differ in some not unimportant particulars.

2. As to the origin of the notochord, their main result is that this structure is formed as an actual thickening of the primitive hypoblast of the anterior part of the area pellucida. It unites posteriorly with a forward growth of the axial tissue of the primitive streak, while it is laterally continuous at first, both with the mesoblast of the lateral plates and with the hypoblast. At a later period its connection with the mesoblast is severed, while the hypoblast becomes differentiated as a continuous layer below it.

As to the hypoblastic origin of the notochord, they are again in complete accord with Gerlach, but differ from him in admitting that the notochord is continuous posteriorly with the axial tissue of the primitive streak, and also at first continuous with the lateral plates of mesoblast.

The authors add:—"The account we have given of the formation of the mesoblast may appear to the reader somewhat fantastic, and on that account not very credible. We believe, however, that if the view which has been elsewhere urged by one of us, that the primitive streak is the homologue of the blastopore of the lower vertebrates, is accepted, the features we have described receive an adequate explanation.

"The growth outwards of part of the mesoblast from the axial line of the primitive streak is a repetition of the well-known growth from the lips of the blastopore. It might have been anticipated that all the layers would fuse along the line of the primitive streak, and that the hypoblast as well as part of the mesoblast would grow out from it. There is, however, clearly a precocious formation of the hypoblast; but the formation of the mesoblast of the primitive streak, partly from the epiblast and partly from the hypoblast, is satisfactorily explained by regarding the whole structure as the blastopore. The two parts of the mesoblast subsequently become indistinguishable, and their difference in origin is, on the above view, to be regarded as simply due to a difference of position, and not as having a deeper significance.

"The differentiation of the later plates of mesoblast of the trunk directly from the hypoblast is again a fundamental feature of vertebrate embryology, occurring in all types from *Amphioxus* upwards, the meaning of which has been fully dealt with in the 'Treatise on Comparative Embryology' by one of us. Lastly, the formation of the notochord from the hypoblast is the typical vertebrate mode of formation of this organ, while the fusion of the layers at the front end of the primitive streak is the universal fusion of the layers at the dorsal lip of the blastopore, which is so well known in the lower vertebrate types."

Development of Lepidosteus.*—Prof. F. M. Balfour and Mr. W. N. Parker state that the ovum is invested by a thick inner membrane, and an outer layer of pyriform bodies, which would seem to be metamorphosed follicular epithelial cells; the segmentation is complete, though very unequal; here, as in the division of the epiblast into an epidermic and a nervous stratum, and in the formation of the walls of the brain, &c., from a solid "medullary keel," we have resemblance to the Teleostei; the same is true of the archinephric duct, which is developed from a hollow ridge of the somatic mesoblast, and, by constriction, gives rise to a duct with an anterior pore, leading into the body-cavity. The olfactory sacs arise as invaginations of the nervous layer of the epiblast, the superficial epidermic layer becoming ruptured to allow of communication with the exterior; the primitive single opening divides to give rise to the double opening of the adult. The suctorial disk of the larva is shown to be formed of papillæ composed of elongated epidermic cells, which probably pour out a viscid secretion. The pronephric chambers remain in communication with the body-cavity by two richly ciliated canals; some of the mesonephric tubes of the larva have peritoneal funnels. No traces of a hyoid gill were detected in any larvæ.

Spermatogenesis in Vertebrates and Annelids.†—A. Sabatier considers that the observations he has made on spermatogenesis in *Salmacina*, one of the Serpulidæ, throw great light on the process in Vertebrates.

The spermatospores, or mother-cells, which line the walls of the spermatic sacs, are, by multiplication of the nuclei and by budding, covered with claviform pedunculated cells, the *protospermoblasts.* Each of these enlarge, detach themselves from the group, and in their turn present a new multiplication of nuclei with superficial budding. Hence arises a second generation of spermatoblasts, the *deutospermoblasts*, which are ultimately transformed into spermatozoïds, the nuclei of the former forming the heads of the latter, while the body and tail are filaments of the protoplasm.

This double generation appears to the author to explain, simply and rationally, the complicated and very extraordinary process attributed by Balbiani to the process of spermatogenesis in vertebrates. The cellular groups composed of a large round central cell (female

* Proc. Roy. Soc., xxxiii. (1881) pp. 112–9.
† Comptes Rendus, xciv. (1882) pp. 172–3.

element), and small peripheral smooth cells applied to their surface (male element), which he considered to be primordial ovules surrounded with epithelial cells, and consequently as young male Graafian follicles, are the primitive spermatospore covered with the protospermoblasts, and the group of daughter-cells, which, according to Balbiani, are produced by budding of the epithelial cells, are in fact the deutospermoblasts.

There is therefore no necessity to imagine the intervention of a conjugation of elements of supposed different sexuality, and a fecundation of which there is no serious proof.

Further researches on the Plagiostomi (*Raja* and *Scyllium*) and Amphibia (*Rana*, *Hyla*, and *Bufo*), have confirmed the author's views. He is also satisfied that the oval refracting bodies observed on the sides of the bundles of spermatozoïds before maturity (the "problematical bodies" of Semper to which Balbiani attributed a very important function as the female fecundating element) are simply nuclei of deutospermoblasts which have not undergone division.

Cell-structure.*—The first portion of W. Flemming's third contribution to this subject deals with the ovum of the Echinodermata. He finds that in the ripe ovarian ovum of the Echinoidea (and it may be supposed in others also), there is a radiate arrangement of the protoplasm of the eggs, which persists and even becomes more distinct during fertilization; this radiation is not to be confused with the formation of the asters. There exists a sperm-nucleus which fuses with the ovarian nucleus; the sperm-nucleus is formed by the anterior portion of the head of the spermatozoon, or that part to which Flemming gives the name of the chromatic substance. The doctrine of Fol, that the protoplasm of the male element alone enters into union, cannot be held; what is rather true is that the chromatin (or nuclear body), both of the male and of the female nucleus, enters into the formation of the cleavage-nucleus. The division of this last, formed, as we have seen, by copulation, differs in no essential respect from the karyokinetic (indirect) division of other cell-nuclei. All the filamentar forms, with unimportant changes in certain phases, are exactly similar to those already noted when describing the division of the nuclei of the cells of tissue. The mother-star of the karyokinetic figure has not the same centre as the radial arrangement of the ovarian protoplasm. The radial forms of the daughter-nuclei have, however, the same centre; but this is true also of other than ovarian cells.

The author insists on the fact that most ova are very unsuitable objects for the study of dividing nuclei; the observations by him on this subject were carried out at Naples on *Sphærechinus brevispinosus*, *Echinus miliaris*, and *Toxopneustes lividus*.

Dealing with the phenomena of nucleus-division in the walls of the embryo-sac of *Lilium* and other plants, Flemming directs attention to the results of Strasburger, from which his own differ considerably. He finds that in all nuclear figures there are many more chromatic filaments than that author has represented, and that these do not

* Arch. Mikr. Anat., xx. (1881) pp. 1–87 (4 pls.).

present considerable enlargements or diminutions in size, but that they are either all of the same thickness, or only here and there present variations, and these of the very slightest character. There is no compact plate in the equatorial plane, but only closely packed coils; in this plane there is frequently to be observed a clear medulla, the presence of which appears to have escaped the notice of Strasburger. After carrying these criticisms further, attention is drawn to many points in which there is a resemblance between the cells of the tissues of animals and plants.

Further studies have been made on karyokinesis and the structure of the nuclei. As to the latter, we may note that the author finds that what he has called the "intermediate substance" of the nucleus contains, after treatment with reagents, and probably also during life, a fine continuation of the nuclear network. The fine granulation which may be seen in the intermediate substance of the nucleus with less powerful lenses, and which was formerly thought to be due to coagulation in a homogeneous mass, is to be referred to this fine framework; the bars, so to speak, of which it is made up are the direct continuation of the coarser, and are chromatic. It is, perhaps, to the presence of these that we have to refer the possibility of colouring the intermediate substance of the nucleus. The nuclear envelope, so far as it is capable of being coloured, consists of small peripheral enlargements of these bars, and is formed of the same substance as they are. The question whether there is an achromatic membrane enclosing the nucleus cannot yet be decided.

After giving some account of the polar corpuscles, Flemming points out that the angles of the filamentar loops, which go to form the stellate chromatic figure, are often distinctly in contact with one of the achromatic fibres; the paleness and fineness of the latter are so extreme that never more than a part of them has ever yet been detected; from what he has seen, however, he concludes that this touching of a chromatic loop with an achromatic filament corresponds to the natural position. It would follow, therefore, that the angle of the loop has been attracted by the filament, and that later on the loops, when the mother-figure divides, would become arranged in two groups.

In some examples of the star or circlet-forms the chromatic filamentar loops lie so freely that they can be counted, with the aid of oil-immersion objectives and Abbe's illuminating apparatus. In the epithelial cells of the buccal and branchial epithelium of the larvæ of salamanders four-and-twenty loops were in three cases quite distinctly made out. In other cases from 17 to 22 were less distinctly seen, and the possibility is that in these cases there were really 24 filaments also.

Dealing lastly with some observations on cell-division in Man, it is stated that in the epithelium of the cornea of an adult subject, the lowermost layers exhibited rare and scattered cell-divisions, but here again, just as in *Salamandra maculata*, the chromatic figures were detected, but the achromatic could not be seen, so small was the object. In the blood of a leucocythæmic patient cell-division with kinetic figures was seen; the blood was excessively rich in colourless cells, and had a yellowish-white colour; of several thousand cells, it was computed that only one per thousand exhibited karyokinesis. From this it may be concluded either that in leucocythæmia the colourless cells multiply by direct constriction of the nucleus, or that indirect cell-division chiefly occurs in the spleen and osseous medulla, so that it is only rarely that cells are caught dividing in the blood itself. Dealing with some deviations from the ordinary mode of cell-division in sarcoma and carcinoma, the author takes the opportunity of insisting on the fact that as an ordinary rule, nuclear division is on the same type in man as in the Amphibia.

Summing up the results at which he has here arrived, Flemming finds that in different objects—ovarian cells, plant-cells, and human epithelia—he has again been able to demonstrate that the physical processes and the corresponding mechanics of kinetic nucleus-division is, or appears to be, everywhere essentially the same; at any rate, there is no reasonable ground for doubting this uniformity. He then passes in detailed review the doctrines of Strasburger, a résumé of which it is impossible to give here. The author states that he sees as yet no ground for doubting that the nucleus is a division-organ for the cell, whether or no it has other functions in addition. This view is the only one which explains the general presence of the nucleus and the complicated kinetic processes of division. The phenomena observed in the nucleus may lead us some day to a true physiology of cell-division, and everything which bears, howsoever slightly, on this point, appears to be of much more importance than any merely morphological facts.

In using the term "homology of the processes," no reference has been imagined to phylogenetic considerations, and if serious objection be taken to its use, we have only to replace it by "homotypy." The questions raised in this connection by Strasburger have no importance for the histologist.

Theory of Amœboid Movements.*—Mr. J. B. Haycraft endeavours to account for the throwing out and subsequent retraction of the pseudopodia (of white blood-corpuscles and unicellular organisms), "pointing out, it may be, but one factor, but that a probable one."

The author's suggestion is that in those corpuscles which exhibit amœboid movements, they are due to contractions of the stroma or network of the protoplasm, which contracts at every part except where the pseudopodium springs from, forcing the interstromal matter at this point through the aperture left patent.

"This accords well with the fact that the pseudopodia seem actually to be projected always as radii from the cell, and that they are of a very hyaline nature. The difficulty is to comprehend the forces engaged in their retraction. There are probably at least three:—(1) the relaxation of the stroma; (2) the viscosity of the substance; and (3) surface tension, in virtue of which a body tends to assume the spherical shape.

* Proc. Roy. Soc. Edin., xi. (1881) pp. 29–33.

Now this may be very well theoretically, but are these three factors equal to the occasion ? is the question before us. I have imitated the structure of the *Amœba* in the following way:—

An indiarubber ball is pierced by two or three holes near together; these should be about the diameter of a common darning-needle. A larger aperture (half an inch across) is then made in the ball, but opposite to the smaller holes, and the ball half filled with white of egg (unboiled) tinted with magenta. The ball represents the stroma, while white of egg takes the place of the interstromal matter. The ball is now dipped into a beaker of water to which sugar has been previously added until its specific gravity is equal to that of white of egg. Place a finger over the aperture through which the ball was filled, and press upon it with the other fingers of the same hand. Beautiful little magenta-stained pseudopodia will be projected from the small apertures into the sugar solution, and on relaxing the pressure, still keeping the finger over the aperture above, the pseudopodia will be completely retracted. I have been able in this way to project them three or four inches, and afterwards they have been completely retracted.

One might use common water in place of sugar solution, but as the specific gravity of the white of egg is greater than that of the water, the pseudopodia, when they have been projected more than an inch or so, break off and fall to the bottom. The size of the aperture is also rather a nice point, for there is one size—roughly $\frac{1}{16}$ inch in diameter—which is best suited for white of egg, although any sized aperture will answer, though not so well. This no doubt varies with the fluid used; ordinary ink may be substituted for white of egg, and oil for the sugar solution."

The author cannot but believe that in the stroma the active cause for these movements is to be sought for, and, as far as he can see, the mode described above for its action is least in antagonism to known facts.

While, no doubt, many of the bulgings seen in the white corpuscle of the newt's blood are due to changes in shape of the whole cell, probably with slight local accumulation of interstromal matter, yet may it not be that many of those fine hyaline processes are but interstromal matter projected from the cell ?

Distinctions between Organisms and Minerals.*—In 1878 G. Fournier, by mixing together certain inorganic salts, produced pseudo-organisms, which in form and structure might easily have been confounded with cryptogamic plants, and similar experiments have now been made by D. Monnier and C. Vogt, who describe them as follows:—

Figured elements presenting all the characteristics of form belonging to organic elements, such as cells, simple and with porous canals, tubes with sides, with septa, and with heterogeneous granular contents, may be produced artificially in an appropriate liquid by the joint action of two salts forming by double decom-

* Comptes Rendus, xciv. (1882) pp. 45–6.

position one insoluble salt or two such. The one of these salts must be dissolved in the liquid, whilst the other must be present in a solid form.

These forms of organic elements (cells, tubes, &c.), being produced either in a liquid of organic or semi-organic origin (such as the saccharate of lime), or an absolutely inorganic liquid (e. g. silicate of soda), there can be no longer any question of distinctive forms characterizing inorganic bodies on the one hand and organic on the other.

The formation of such pseudo-organic figured elements depends on the nature, the degree of viscosity, and the concentration of the liquids in which they are produced. Certain viscid liquids, such as solutions of gum arabic, or of zinc chloride, yield nothing of the kind.

The forms of these pseudo-organic products are constant with reference to the salt employed, and constant also as any crystalline form of minerals. This characteristic form is so well maintained that it may even serve for the detection in mixtures of a very minute proportion of a substance. This form may be employed as a means of analysis, as sensitive as spectral analysis, and to distinguish for instance the alkaline carbonates, sesqui-carbonates, and bi-carbonates from one another.

The form of the artificial pseudo-organic elements depends principally on the acid which enters into the composition of the solid salt. The sulphates and the phosphates in certain cases produce tubes, whilst the carbonates give rise to cells.

With some exceptions, such as copper, cadmium, zinc, and nickel sulphates, the pseudo-organic forms are only produced by means of substances which are found in real organisms. Thus the saccharate of lime produces organic forms, whilst those of strontia and baryta do not.

The artificial pseudo-organic elements are enveloped in true membranes possessing a high degree of dialysing power, and giving passage only to liquids. They have heterogeneous contents, and produce in their interior granulations arranged in a regular order. They are, therefore, both in form and constitution, absolutely similar to the figured elements of which organisms are constructed.

It is probable that the inorganic elements contained in organic protoplasm play a certain part in the constitution of the figured organic elements for the determination of the forms which those elements present.

It is suggested * that by these experiments one of the characters by which mere lifeless matter was till yesterday differentiated from the living organism is wiped out. There are no longer any distinctive forms by which we may distinguish the two great classes, and it is asked whether it is not very possible that such structures might be produced without human intention and interference, in what may be called an accidental manner? Might they not, considering the large proportion of silica which they contain, become preserved for ages, and continue to display pseudo-organic features? Suppose we find, in

* Journ. of Sci., iv. (1882) pp. 148-53.

a rock, certain structures exhibiting apparently organic cells, are they the remains of true organisms or of pseudo-organisms? This consideration, at least till it has been further studied, is not without its bearing upon such questions as the organic or mineral nature of the structures found in meteorites, and, e. g., of *Eozoon canadense.*

B. INVERTEBRATA.

"Symbiosis of Animals with Plants"—Chlorophyll-corpuscles and Amyloid Deposits of Spongilla and Hydra.*—Professor E. R. Lankester discusses this subject in an interesting article, with special reference to the recent views of K. Brandt † (endorsing those of Semper) that the green-coloured corpuscles found in the cells of *Spongilla fluviatilis* and *Hydra viridis* are not similar in nature to the chlorophyll-bodies of plants, but are parasitic or "symbiotic" unicellular algæ.

Whilst Professor Lankester considers that there is "very nearly sufficient ground" for accepting the existence of "symbiosis" so far as regards the "yellow cells" of Anthozoa and Radiolarians, yet he regards Semper and Brandt's extension of it to *Spongilla* and *Hydra* as not justified. It appears to him that the green-coloured corpuscles found in the latter case are clearly similar in nature to the chlorophyll-bodies of green plants, and that "there is no more reason to regard them as symbiotic algæ than there is to regard the green corpuscles in the leaf of a buttercup as such."

In the course of the discussion it is pointed out that the investigation of the claims of any given greenish-coloured pigment to be regarded as "chlorophyll" is by no means a simple matter. Supposing the pigment to be soluble in alcohol, we still have to ascertain which of Sorby's three groups (chlorophylls, xanthophylls, lichnoxanthines), are present, and which of each of the species distinguished by him within those groups.

In order to do this we have to rely on:—

1st. Variations in degree of solubility in such media as alcohol, ether, benzine, carbon bisulphide.

2nd. Absorption spectra of the series of solutions obtained.

3rd. Fluorescence and spectrum of the fluorescent light of such solutions.

4th. Reactions of the solutions with acids, alkalies, and oxidizing and reducing agents, which give rise to new compounds or change the spectra characteristically.

There are, however, two other categories of phenomena in relation to the chlorophyll-bodies of green plants which comprise data of a nature to assist us in judging of the similarity or dissimilarity of the green pigments of animals compared with that of the chlorophyll-bodies. There are, 5thly, the *physiological* activities associated with the chlorophyll-bodies of plants; and 6thly, the *morphological* features of these bodies.

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 229-54 (1 pl.).
† See this Journal, *ante*, p. 241.

If we find in an organism physiological processes associated with the presence of a green pigment, which processes are identical with those associated with the presence of the green pigment occurring in the chlorophyll-bodies of plants, we have so far a certain amount of evidence in favour of the identity of the green pigment in the two cases. And again, if we find that the green pigment in an organism occurs in corpuscles which are morphologically similar to the chlorophyll-bodies of plants, we have so far evidence in favour of the identity of the green pigment in the two cases.

In the author's view there is only one animal—*Spongilla fluviatilis*—in which the presence of chlorophyll has been definitely established by chemical and spectroscopical investigation (Dr. Sorby). The full corroboration by physiological and morphological evidence is still wanting, although to Mr. Geddes' physiological researches on *Convoluta Schulzii* "some value must be ascribed." Similar physiological evidence in favour of the assimilation of the green pigment of *Hydra viridis* to that of green plants has also been obtained by Mr. J. E. Blomfield.

A full statement is given of the author's own observations with reference to the *form* under which the green pigment of *Spongilla* occurs, which confirm the spectroscopic evidence, and refute the view of Dr. Brandt that chlorophyll is never formed by animal organisms, but, when found in animal cells, is due to the presence of parasitic algæ. No cell-nucleus really exists in connection with the green corpuscles of *Spongilla* or *Hydra* as asserted by Brandt, nor does his important observation of the formation of starch in isolated chlorophyll-corpuscles tend in any way to prove that they are independent organisms but simply that a bit of protoplasm with its associated envelope or cap of green substance can retain its vital activity just as a piece of *Amœba* can. From Brandt's account of his experiments in infecting Infusoria with the supposed parasites of *Spongilla* and *Hydra*, it is at once apparent that they are *opposed* to and not in favour of the parasitic theory. The chlorophyll-corpuscles of *Spongilla* were digested or else ejected by the infected Infusoria. In other cases the chlorophyll-corpuscles of *Hydra* remained in the Infusorian's body *unchanged*. Had Brandt's view been confirmed, the green corpuscle ought to have multiplied in its new host, and even such evidence of a temporary manifestation of vitality after removal from the *Hydra* or *Spongilla* would not be at all conclusive to the effect that the chlorophyll-corpuscles are independent organisms, and not parts of the protoplasm of the cell in which they are normally found.

With regard to *Hydra*, a very strong argument against the supposed parasitism is found in the fact noticed by Kleinenberg that minute angular fragments of a given colour are often present together with the normal corpuscles. These present no difficulty if the corpuscles are regarded as products of the animal's cell-protoplasm, but are inexplicable on the parasite theory.

The final conclusion is that a careful study of the chlorophyll-corpuscles of *Spongilla* and *Hydra* reveals their correspondence with the known structure of the chlorophyll-bodies of plants; and those who, like Semper and Brandt, have supposed them to be parasites, have been misled, first by an imperfect acquaintance with the character of chlorophyll-bodies in general and of these in particular, and secondly by the plausible but delusive analogy presented by the "yellow-cells" of Radiolarians and of Anthozoa.

There is a field for experimental inquiry in regard to animal chlorophyll, as it is very important to know whether it serves the same purpose as in the plant, and if so, whether we may not be able to get indications as to the disputed function of the green pigment which plants are unable to furnish.

Palæontological Significance of the Tracks of Different Invertebrates.—Herr Nathorst has instituted some very interesting and important experiments in explanation of the traces in rock formations of various organisms. As we have not the original, we give the following report on it by T. Fuchs: *—"In the sandstone and marl of all formations there are often found, in greater or less quantities, certain marks and imprints the nature of which has been hitherto problematical, as they have been interpreted either as algæ or animals, or simply regarded as inexplicable. Such are the *Fucoides Harlani* from the Cambrian of America, the *Nemertites* of the culm-shales, the '*Zopfplatten*' (a term applied to flattened hair-like impressions) of the Jura, the endless varieties of different 'hieroglyphs' of the Flysch formation, as well as the various impressions described as *Prolichnites*, *Eophyton*, *Spirophyton*, *Taonurus*, &c.

Nathorst has hit upon the happy idea of solving this problem by allowing different animals to crawl or run over soft mud, and then studying the tracks thus made by them. Although he has only experimented with about 40 marine animals, and a few insects, larvæ, and earth-worms, still the result of his researches was truly astonishing, as he succeeded not only in artificially representing the finest *Nemertites*, *Harlaniæ*, '*Zopfplatten*,' *Eophyton*, &c., but he made the most unexpected discovery, that by far the greater number of the so-called 'Fucoids' (e.g. *Buthotrephis*, *Chondrites bollensis*, *Ch. hechingensis*, and even the Fucoids of the Flysch, are nothing else than branched worm-tubes. However unexpected this discovery may be, there can hardly exist a doubt as to its accuracy after the experiments and evidence of the author. On taking several worms of the species *Goniada* and *Glycerea*, which are found in great numbers on the coasts of Norway, and allowing them to crawl over soft mud, he observed, to his astonishment, that they invariably made a branched track, like the twigs of a tree. They first advance a short distance, then go back a little over the track, and turn away on one side, thus producing a branch; this they repeat from different points and on different sides, finally returning to the point whence they started, and make a second main track in another direction, which they

* Handl. K. Svenska Vetens. Akad., xviii. (1881). Verh. k. k. Geol. Reichsanst., 1881, p. 346. See Naturforscher, xv. (1882) pp. 113-16.

branch in the same manner as before. In this way a whole tree is produced.

This manœuvre is carried out by the worms, not merely on the surface, but they also burrow into the mud and from a given point produce a system of branched tubes, which being lined with a slimy coating, acquire a certain firmness. If a thin mixture of plaster of Paris be carefully poured over this perforated mud or clay, it will enter the tubes, and by carefully washing off the mud after the plaster is fixed, the cast of the tubes will bear the appearance of a delicate tree.

If it is assumed that a bed of mud or clay can be thus burrowed by *Goniada* and *Glycerea*, and that the burrows can be filled with a soft substance, there will consequently be seen in a section of this bed, branched impressions which have the appearance of Algæ, but which are, in reality, branched tubes made by worms.

With regard to the fossil *Chondrites*, especially *Chondrites bollensis* and *hechingensis*, and the Chondrites of the Flysch, it had already occurred to many that these so-called Fucoids did not lie, like other fossil plants, pressed flat between the strata, but that they were found much more nearly in their proper form in the beds of marl, as though they had grown through them. It was also remarkable that they were never found in a carbonaceous condition, but invariably in marl. Heer has also drawn attention to the fact that these 'Fucoids' occur in all formations, from the lias to the upper eocene, in almost identical forms, while in existing seas hardly any analogous specimens can be found. This fact was the more inexplicable when it was considered that, for example, the algæ of the Paris limestone, or the Flysch of Monte Bolca bore the closest resemblance to the existing forms of algæ, so that at the period of the eocene formation, types of algæ existed analogous with the present.

There were also other difficulties. Algæ always grow only in small depths on a firm foundation, and never in mud. Now the localities in which the so-called Fucoids are found in the greatest quantities are manifestly formations of mud, and deposited in a deep sea.*

All these difficulties at once vanish when it is known that these so-called 'Fucoids' of the Flysch are not algæ, but only the tracks of worms; the peculiarity of their origin is then no longer incomprehensible. Worms are to be found in the sea at a great depth, and like especially slime and sand; and it thus becomes evident that such perishable impressions as those made by worms are more lasting in the deep sea than in the formations nearer the shore, because they are not so easily effaced or disturbed.

Among other marks observed by Nathorst, the following may be mentioned:—*Corophium longicorne* (a Crustacean) makes an impression

* It might of course be assumed that algæ, like *Sargassum*, torn from the place where they grew, and driven out to sea, finally sink down into the mud of the deep sea, but even with such an hypothesis these Algæ would always appear unusual and accidental, while the Chondrites in the Flysch have a constant characteristic.

which corresponds exactly with the '*Zopfen*' of the so-called '*Zopfplatten*'; *Idothea baltica* forms Prolichnites; a Planarian makes a flat, ribbon-like track; *Montacuta* makes dentated impressions, which closely resemble Graptolithes; an unknown animal makes a regular, zigzag, serpentine mark; a piece of an alga drawn over mud produced a streaked mark which corresponded exactly with what is described as *Eophyton*, and which has hitherto been considered a plant. Similar impressions were made by the tentacles of Medusæ. Drops of water falling upon mud covered with a thin stratum of water produced remarkable, regular, wheel-shaped figures, which at a distance recall Medusæ. An earthworm made an impression very similar to what is usually described as *Spirophyton*, and hitherto considered an alga. This was produced in the following manner:—In creeping over the wet mud, the worm suddenly came to a stand; and while its hinder part remained motionless, the anterior was stretched out, while it at the same time bent itself so much to the side that its head was brought close to the other extremity of the body. After the front part had thus been stretched to its fullest extent, it was suddenly drawn back again, without, however, altering the position of the hinder part and the head.

A complete review is also given of the marks of animals found in the Swedish rocks, and a catalogue of 129 publications in which these marks are described and illustrated. At the end of the list is a work by Saporta and Marion, which appeared about the same time as Nathorst's, with the title, 'L'évolution du règne végétale, les Cryptogames.' In this the authors endeavour to explain, according to the Darwinian theory, the gradual evolution of plants from the earliest stages, through the series of geological formations to the present day. Unfortunately" (it is said), "the greater number of fossil remains regarded in this book as plants are in reality the marks of worms."*

Nathorst has also published a second interesting paper † on the origin of particular marks, which Herr Fuchs abstracts as follows:—

"Some time ago peculiar unknown bodies were found in the Cambrian strata of Lugnas in Sweden, which were described by Torell and Linnarson under the names of *Spatangopsis costata* and *Astylospongia radiata.* These bodies are in the form of 4–5 rayed stars or 4–5 cornered pyramids, which either lie free in the mud, or with the under surface adhering to the rocks, or form only an impression on a slab. Between the rays and corners are occasionally to be seen crescent-shaped projections. When Nathorst was at Oeresund in 1880, it happened that a large number of *Aureliæ* were thrown on the shore. The animals all lay with the mouth downwards, and when he took one up he observed that it had sunk in the soft ground by its own weight, and that its gastrovascular system had made a star-like impression, showing the most striking resemblance to the so-called *Spatangopsis.* He then followed up the matter further, partly by making impressions of various *Medusæ*, and partly by filling up their gastrovascular system with plaster, and so obtained a

* A rather too sweeping assertion.—Ed.

† Handl. K. Svenska Vetens. Akad., xix. (1882).

cast. The preparations thus made corresponded so exactly in every detail with the problematical bodies from the Cambrian, that no doubt could exist as to their identity. The stars and pyramids are casts of the gastrovascular systems of the Medusæ, the rays of the stars and the angles of the pyramids correspond with the arms, and the crescent-shaped projections occasionally occurring between the angles are casts of the genital cavities. The impressions on the slabs of rock are produced by Medusæ thrown on the shore, and which, sinking more or less into the soft ground by their own weight, make a more or less complete impression of the body-cavity. The bodies lying free in the clay were probably produced by Medusæ which lay on their backs, their gastrovascular system becoming filled up with sand or mud. There are some Medusæ which do not swim, but sink into the mud on their backs, and lie still watching for their prey.

The fact that the number of rays in these fossils varies from 4 to 5 is not an objection to their medusoid nature because in the present day individuals are found with 5, 6 or 9 rays. Certainly this deviation from the normal number appears more frequently in the Cambrian Medusæ than in the existing species.

The impression of the disk and traces of the tentacles are still distinctly seen round a four-rayed star on a rock from Lugnas. Many slabs are covered with thick, spiral, vermicular bodies, which Nathorst considers to be arms torn from Medusæ. Certain thread-like marks on sandstone were supposed by him to be made by swimming Medusæ that grazed the ground with their tentacles. He was also of opinion that the so-called Eophytes, which occur in great quantities in the same strata as the Medusæ fossils, were without doubt produced by creeping Medusæ.

The following species of Medusæ from Lugnas have been distinguished by him: (1) *Medusites radiatus* Linnars. sp.; (2) *Medusites favosus* n. sp.; (3) *Medusites Lindströmi* Linnars. sp.

Hitherto Medusæ were only recognized with certainty in the Solenhofen slate, and the discovery of Nathorst is therefore of great interest. It is especially interesting also because these Medusæ occur in the deepest strata that have ever produced fossils, so that they must be reckoned as amongst the oldest animals whose tracks are known to us."

Lymph of Invertebrates.*—C. F. W. Krukenberg obtained 12–14 drops of pure lymph from a medium-sized *Hydrophilus piceus*; he finds that the lymph varies remarkably in different individuals, the colour being different even when the specimens have lived under the same conditions. The coagulation which is spontaneously formed in it is, compared with that of the hæmolymph of Mollusca and Crustacea, of a more membranous nature, and not gelatinous; the lymph undergoes coagulation at a comparatively low temperature. The melanotic change of colour presents remarkable individual variations, which lead to the belief that the body which blackens immediately on exposure to the air is in certain cases preformed in the circulating lymph. The

* Verh. Nat. Med. Ver. Heidelberg, iii. (1881).

hæmolymph of *Planorbis*, like that of Vermes, does not coagulate spontaneously; the coagulation temperature is very different to that of the hæmolymph of the Gastropoda, for while this coagulates at 60° C., a small amount of fluid can be filtered from the former at 64° C. The coloration of the fluid of *Planorbis* is solely due to its hæmoglobin, but the intensity of the colour is never so marked as it is generally in the Mammalia.

Mollusca.

Development of the Cephalopoda.*— Dr. M. Ussow, in describing the formation of the germinal glands, points out that the unpaired ovary is a conical sac occupying the lower part of the trunk, and often, when mature, of considerable size. The ripe ova fall into the cœlom, and thence by the ciliated epithelium are carried to the oviduct. By the antiperistaltic movements of these latter, they are conveyed into the respiratory cavity, and thence by the contraction of the funnel to the exterior. The Graafian follicles are so arranged that the central portion of the ovary is occupied with the younger or with the primordial ova. Each follicle has a separate theca, which is well provided with blood-vessels coming from the genital arteries. The first rudiments of the germinal glands appear during the periods of embryonic development, the small group of rounded mesodermal cells which appear in the third developmental period near the narrow end of the mantle and behind the systemic hearts, being, undoubtedly, converted into ovarian glands or sperm-glands. Further development, and the formation of the efferent ducts appear to be post-embryonic. During these changes the mesodermal cells become converted into a number of racemose Graafian follicles, the walls of which are formed by the thin theca, and by a uni- or bilaminate *membrana granulosa*. A primordial ovum and the formative yolk are nothing more than a differentiated and greatly developed epithelial cell of the ovary. As the cell grows the Graafian follicles increase in size; folds then appear owing to the development of the *granulosa-cells*, their glandular inner surface increases, and secretes the nutrient fluids. The chorion is not formed till the secretion of the yolk is completed, and when it is formed there appears the micropyle; the chorion is elastic and transparent. Beneath it in the mature egg there is an inconsiderable quantity of fluid, which coagulates on heating, and within this there is the formative yolk, formed of a finely granular protoplasm and investing the less fluid nutrient yolk.

The first developmental period extends from the commencement of segmentation to the first appearance of the rudiments of the organs; there appears to be a striking similarity in the phenomena exhibited by different members of the group. At first all the cleavage-cells appear at one pole of the egg, the grooves extending from the central portion of the formative yolk outwards; the nutrient yolk is regarded by the author, in opposition to Prof. Lankester, as playing a merely passive part. Cleavage is at first superficial and only gradually extends to the more deeply lying parts; in *Argonauta argo* there was

* Arch. de Biol., ii. (1881) pp. 553–635 (2 pls.).

an interval of about one or two hours between fertilization and the appearance of the first two segmentation-spheres; in the other forms from 5–8 hours. After describing the process of segmentation in full, and discussing the results of earlier observers, Dr. Ussow passes to the next step, in which the blastoderm, &c., are developed. In the germinal disk it is possible to distinguish (1) the central portion, (2) the median portion, or *area opaca*, more or less ring-shaped in form, and (3) the lower protoplasmic portion, not yet differentiated into cells and continued as far as the lower pole of the egg. The central portion is formed by a single layer and consists of small, polygonal cells derived from the division of the six primary and two secondary cleavage spheres. In the fresh condition the finely granular protoplasm and the sharply contoured nuclei are quite transparent. The cells are almost all of the same size (0·016 mm.), the peripheral ones being alone somewhat larger. At first flattened, they gradually become cylindrical; and frequently alter in form by dividing longitudinally. The cells of the *area opaca* are longer, unequal in size, and polygonal in form; there are only two or three concentric rows; they owe their origin to the multiplication of those cleavage-cells which had been separated off by the development of the equatorial groove. They are dark in appearance, owing to the consistency of their protoplasm, and the thickness of the layer. The broadest and lower portion consists at one time of 32 segments, which are frequently arranged in pairs; as there is not a single large cleavage-cell, but 2–6 cells at the thickened apex of each segment, the edge of the germinal disk is irregular and villous owing to the projecting angles of the cells; between each pair of segments there is a clear intermediate space, filled up by an extremely thin layer of the formative yolk; this disappears as the blastodermic cells multiply. A little later (36th hour) there appear the rounded cells of the mesoderm; these arise from the cells of the median portion, which undergo transverse division; each of the cells so formed is rounded, and gradually takes on a cylindrical form. As soon as these cells appear the process of division begins to affect all the cells of these parts of the germinal disk, and is effected either transversely or longitudinally. Three or four successive rows of the larger blastoderm-cells, forming the median portion, divide longitudinally as soon as they have divided transversely; this, of course, increases the breadth of the median portion, which also becomes a thicker and therefore a darker ring; this ring surrounds the unilaminate and still transparent central portion. The other six days of the first developmental period are occupied by the multiplication of the cells of the peripheral portion of the germinal disk; the upper and median germinal layers extend over the surface of the nutrient yolk.

At the end of the second day of development the middle layers consist of several rows of cells; at the same time the ectodermal cells have continued to undergo transverse division, and have thus narrowed the central portion of the germinal disk. On the third day, separate groups of mesodermal cells make their way into the central portion, and towards the end of that day the upper limits of the mesoderm are brought nearer to the superior pole of the egg. The layer which in all Cephalopods forms the wall of the outer yolk-sac, appears to the author to be simply formed of mesodermal cells, of which it would appear to be a direct continuation. The various facts which Dr. Ussow has observed lead him to think that in the Cephalopoda the mesoderm is not folded off from the ectoderm, but simply arises from the transverse division of the cells of that layer. Later, the diameter of the unilaminate central portion decreases considerably, while the median zone grows both centrifugally and centripetally. The cells of the ectoderm at first vary in form and size in different parts of the embryo; later on they all become short epithelial cells; but it is not till the ninth or tenth day that they are to be sharply distinguished from all the rest, and they are then cylindrical in form. The mesoderm grows in two directions, towards the central portion of the germ and the equator of the egg.

Contrary to the opinion of Kölliker and others, the author is convinced that all the Cephalopoda begin to develope from the dorsal side, and not from the hinder end of their body. Further observations are promised.

Development of the Oyster.*—Dr. R. Horst points out that the groove or depression described by Davaine and Lacaze-Duthiers is the invagination of the embryo, and that the dorsal depression regarded by Brooks as being the opening of the intestinal tube is really the shell-gland-invagination. These two inpushings, possessed by the oyster at one and the same stage, are almost equally well developed; later on the ventral side becomes a little pushed out so as to form a kind of foot. The abdominal cavity is formed by the separation of the ectoderm from the endoderm. The author confirms the doctrine of Salensky and Hatschek that the first rudiment of the shell is an unpaired formation, and he thinks that this is true of all Mollusca; Carbonate of lime is very early deposited in the shell. The white spat becomes black spat by the deposition of pigment at different points in the body of the larva. On the ventral face there is a button-like thickening of the ectoderm, which is probably the commencing rudiment of the otocyst.

Abortion of Reproductive Organs of Vitrina.†—F. d'A. Furtado, on examining seven specimens of *Vitrina* from the Azores, found that there was not the least trace of any reproductive organs, and Professor L. C. Miall confirms the observation as regards three other specimens sent to him. Abortion of the reproductive organs has been observed in animals infested by parasites, e. g. in stylopized bees, in *Lymnæa stagnalis* when attacked by Trematodes, and in female hermit-crabs attacked by Rhizocephala. The complete abortion of the parts, writes Professor Miall in the remarkable case described by Mr. Furtado, distinguishes it at once from the many cases of real or supposed functional defect met with in hybrids.

* Zool. Anzeig., v. (1882) pp. 160–2.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 397–9.

Morphology of the Amphineura.*—Dr. A. A. W. Hubrecht gives a convenient summary of the actual state of our knowledge of this class of animals, including a brief statement of what is "known, surmised, uncertain, or unknown," with respect to (*a*) integument, (*b*) nervous system, (*c*) intestine, (*d*) circulatory and respiratory apparatus, (*e*) reproductive and excretory organs.

Molluscoida.

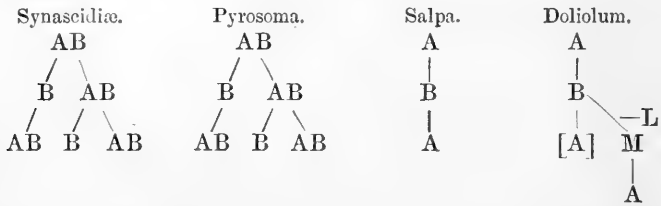
New Synascidian.†—Dr. R. Drasche describes *Oxycorynia fascicularis*, which are found in cylindrical trunks of as much as 6 cm. in length; the colour of the colony is a dirty green, and the individuals which are only 10 mm. long have the branchial sac 6 mm. long. The rounded cloacal orifice is found at the uppermost tip of the sac. The animals are connected together by a very delicate and transparent tunic. The nearest ally would seem to be the *Chondrostachthys* of Macdonald.

Alternation of Generations in Doliolum.‡—Dr. Carl Grobben describes this phenomenon in detail, and amongst more general considerations, points out that nearly all animals which reproduce themselves by gemmation are of a fixed habit, the matter which is not used up in the work of locomotion being applied to the production and nutrition of buds; gemmation being inconveniently carried on by a free-swimming form, we must suppose that such free forms as do multiply thus are derived from ancestors that were fixed; we have a good example in the Siphonophora, and the same view may be applied to the Salpidæ.

The simplest mode of alternation of generations is, perhaps, to be seen in some compound Ascidians, where the individuals that arise from ova are sterile, while those that are developed from buds develope generative organs. This is a division of labour. In *Pyrosoma* the ovum gives rise to a cyathozooid, whence appear four ascidiozooids, and these multiply either by gemmation or by the formation of sexual elements. In the true Salpidæ the nurse developed from the egg gives rise to a chain of apparently very different forms which are altogether sexual in their mode of development. Here then there is a complete division of labour, and this is clearly due to their free life. Coming lastly to *Doliolum*, we find that here the larva developed from the egg, after losing its tail, gives rise to lateral and then to median buds, which latter provide the sexual forms. The differences between the zooids are considerable: the nurse has nine, the sexual form has only eight muscular bands; the former has an auditory organ which the latter is without; the first nurse of *Doliolum* has its stolon dorsal, and is therefore without a homologue in the rest of the Tunicata; in other words, it is a structure which has been independently developed, and in

* Quart. Journ. Micr. Sci., xxii. (1882) pp. 212–28 (11 figs.).
† Zool. Anzeig., v. (1882) pp. 162–3.
‡ Claus' Arbeit., iv. (1882) pp. 201–99 (5 pls.).

consequence of its appearance the ventral stolon of other Tunicates has been arrested in its development, and has become a rudimentary organ. The appearance of this new, dorsal, stolon is explained by the inherited capacity of the Doliolida to produce new structures by gemmation, and its supersession of the ventral one by the following hypothesis: the dorsal stolon is shown to be more embryonic than the ventral one by the fact of its only being formed of the three germinal layers, and not, like the latter, of six rudiments; we know that embryonic tissues have a much more considerable growth-energy than those that are more highly differentiated, and this advantage became more and more marked by the influence of heredity. The relations of the different generations is shown in the following diagrams, where a letter or a combination of letters marks a generation, A is a sexual, B an asexual generation, M the median, and L the lateral buds.



Dr. Grobben next passes to the phylogenetic history of alternation of generations in the Acalephæ; in the Hydroids, as Leuckart has shown, it is due to division of labour, in consequence of which only some individuals of the colony have produced generative products, and the Medusæ have been derived by natural selection from the free-swimming generative polyps. In the Acalephæ the phenomenon is likewise due to division of labour among the members of a colony. After a special reference to the studies of Professor Semper, the author passes to the Cestodes, where he does not discuss the question of the phylogenetic development, but merely raises the question whether we have here to deal with true alternation. He comes to the conclusion that it is not so, but that we have only a simple metamorphosis, the larva, vesicle, scolex, and strobila being one and the same individual in different stages of development. This is true of the common *Tænia*, but it does not apply to those cysticercoid forms in which several heads are developed, for each head represents a Tænia-individual with the power of developing proglottids. The history of the Trematoda is dealt with in the same manner, and it is pointed out that we have here to do not with alternation of generations, but with heterogony. The author comes to the conclusion that the so-called spores are ova capable of developing without fertilization; the generative products are either single cells (ova), or are derived from the germinal layers of the mother. In the one case we have sexual, and in the other asexual development; or, in other words, unisexual and bisexual generations appear alternately in the cycle.

Arthropoda.

α. Insecta.

Nervous System of the Larvæ of Diptera.*—E. Brandt has continued his researches on the nervous system of insects.† In the larvæ of the Leptidæ, Bibionidæ, Therevidæ, Xylophagidæ, and Dolichopodidæ (families whose nervous system has not hitherto been examined) there are thirteen ganglia, two cephalic, three thoracic, and eight abdominal. In the Leptidæ, the ganglia, instead of being joined by the simple commissures as in all other Diptera, are united by double nervous cords, as in the adult. In the next three families the two first thoracic ganglia are close to one another, while the third is further off. As the adult has only two thoracic ganglia, the first is evidently derived from the union of the first two of the larva. In the Dolichopodidæ the adult has no abdominal ganglia, and the second thoracic ganglion is therefore evidently derived from the fusion of the third of the larva with all the abdominal ganglia.

Several genera and species of families which have already been partially examined are also described, and the author finds that in the Tabanidæ the larvæ have seven ganglia, and not two only, as described by J. Künckel d'Herculais.

Occident Ants.‡—Dr. H. C. M'Cook publishes in a collected form his observations on the Honey Ants of the Garden of the Gods, which we have already dealt with in this Journal,§ and the Occident Ants of the American plains.

The occident ants build mounds of from less than half a foot to more than a foot in height, round which they make a circular "clearing" of grass and other vegetation, presumably by cutting it away after the manner of the agricultural ants of Texas, previously described by Dr. M'Cook. The mound is always covered with pebbles which have been removed in the process of excavating the underground chambers and galleries. Some of the pebbles so transported are ten times the weight of the ant, so that the labour performed would be paralleled by that of a man if he could carry half a ton up a staircase one-third of a mile high.

The ants do not begin their labour till eight or nine o'clock in the morning; so that, as Dr. M'Cook seems not unwilling to observe, "it might not be unmeet that those persons whose love of sleep during late morning hours has been disturbed by the familiar Scripture proverb, 'Go to the ant, thou sluggard; consider her ways, and be wise!' should return upon their mentors with the above-recorded facts, and cite this ant, who is indeed no sluggard, as being nevertheless fond of a morning nap." The day's work, or at any rate the day of outdoor work, begins by opening the gates which had been closed

* Comptes Rendus, xciv. (1882) pp. 982–5.

† See this Journal, i. (1881) pp. 234–5.

‡ M'Cook, H. C., 'The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains.' 8vo, Philadelphia, 1882. Cf. Mr. G. J. Romanes in 'Nature,' xxv. (1882) pp. 405–7.

§ See this Journal, iii. (1880) pp. 242 and 775.

the previous evening. "The manner of opening the gate cannot be fully described, because the work is chiefly done within and behind the outer door of gravel. The mode would doubtless be correctly indicated by reversing the process of closing gates presently described. What I saw was, first, the appearance of the quivering pair of antennæ above one of the pebbles, followed quickly by the brown head and feet projected through the interstices or joints of the contingent gravel-stones. Then forth issues a single worker, who peeps to this side and that, and after compassing a little circuit round about the gate, or perhaps without further ceremony, seizes a pebble, bears it off, deposits it a few inches from the gate, and returns to repeat the task; she is followed sometimes cautiously and at intervals of ten, twenty, even thirty minutes, by a few other ants, who aid in clearing away the barricade, after which the general exit occurs. Again there is a rush of workers almost immediately after the first break, who usually spread over the hill, bristling around the gate, gradually widening the circles, and finally push out into the surrounding herbage. At first the exit hole is the size of a pea, perfectly round, and plainly shows that sand and soil have been used under the gravel to seal up the gate. The whole appeared to have been cemented, probably by the moisture of the night dew.

"The process of closing the gates is even more interesting to the observer than the opening, as the various steps are more under his notice. . . . At nest A the closing was chiefly from within. The workers pushed the sand from the inside outwards with their heads. A grass straw about an inch long was brought from the interior and pushed out until it lay across the gate as a stay for the filling material. Soil was here principally used for closing, a few pebbles being added." In another case, "when the gate was nearly closed a straggling minor came back from the commons and essayed entrance, wherein she failed. Several trials and failures succeeded, whereupon she commenced dragging the dirt from the opening. While thus engaged the major approached with a huge bit of gravel, which she deposited on her comrade with as much nonchalance as though she were one of the adjoining pebbles. At last the minor dug out a tiny hole through which she squeezed into the nest, and the major, who was deliberately approaching close behind her, carrying another pebble, immediately sealed up the opening. During this amusing episode the straggler made no effort to aid in the closing, being wholly intent on entering, and the gate-closer paid no attention to her whatever, beyond the first sudden and satisfactory antennal challenge. Each moved forward to her own duty with the undisturbed plasticity of a machine."

This "by-play" between the gate-closers and the late-returning foragers is not the exception but the rule; nevertheless it does not appear that the foragers ever so far miscalculate their time as to arrive after the gates are completely closed. When the gates are all but closed there is generally but a single ant engaged in the closing process from without; this ant slips in at the last moment, and the process is finally concluded from within. The gates are similarly shut during the day-time if the weather seems to threaten a heavy rain-storm.

The ants, though provided with very formidable stings, are exceedingly mild and unwarlike. They present the same habits of "harvesting" as those which were previously known to occur in allied species of Florida and Texas.

γ. Arachnida.

Pycnogonida.*—After a review of what has been done by preceding naturalists, Dr. P. P. C. Hoek discusses the general form of the body; this is strictly bi-lateral, with a proboscis, four segments, and a rudimentary abdomen. The first segment is formed of one cephalic and of one thoracic ring; the proboscis ought not to be regarded as a head, it varies in form, and in length, and in the mode of its attachment to the cephalothoracic segments. The body may be slender or robust, the segmentation distinct or obscured; the abdomen is represented by a single joint, the length of which varies considerably; the surface of the body may be smooth or hairy, with or without tubercles or spines. There are never more than seven pairs of appendages, and when all are present three belong to the cephalothorax, and are known respectively as mandibles, palpi, and ovigerous legs; when the first are complete, they have three joints and a terminal pincer (*Pallenopsis*); in some cases (*Pycnogonum*) the mandibles altogether disappear in the adult state. The palps would appear to have primitively a number of joints, and this number varies even within the limits of a genus. There may be ten joints or as few as three, or the palps may disappear altogether. The females of all species, however, retain the ovigerous legs, and they are frequently also represented in the male. The nervous system consists, as usual, of a cerebrum, an œsophageal collar, and a ventral ganglionic chain; in the last there are four or five ganglia, *Phoxichilus* presenting an intermediate condition in having the first of its ventral ganglia small in size, and closely applied to the second; all are distinctly bilobate, the coalescence of the paired parts being complete. Concrescence never attains to the extent exhibited in the Brachyurous Crustacea, for even in *Ammœthea* it is possible, by the aid of reagents, to discover the connecting fibres. Nor, indeed, can external form be taken as giving any true idea of the extent of fusion, for *Pycnogonum*, in which there is an extreme condition of external "concentration," has the ganglia separated by some considerable distance. After a further discussion of allied points, the author states the eyes of the Pycnogonida have generally a very complex composition; ganglion-cells and rods can always be made out, but there would not appear to be any vitreous body; a lens is developed from the integument. The buccal orifice is triangular, and almost immediately dilates into a very large pharynx; at its end there is a constriction and a canal is developed, the length of which depends on that of the cephalic part of the cephalothoracic segment. The inner face of the cells lining

* Arch. Zool. Expér. et Gén., ix. (1881) pp. 445–542 (8 pls.).

this latter are invested in a delicate chitinous layer. The termination of the œsophagus is not abrupt; its three inner faces are prolonged towards the interior of the intestine, and give rise to three outgrowths which have all the appearance of special glands; tubular prolongations are, as is well known, connected with the intestine, but, though they no doubt are very important physiologically, the author has grave doubts as to their morphological significance.

Great difficulties seem to attend a satisfactory study of the circulatory system; the heart has three cavities, at the end of each of which there is a pair of orifices; it is probable that there is an aorta, although it has not yet been detected; as the author has mentioned in his 'Challenger' report, the dorsal surface of the heart is remarkable for having no muscular fibres.

The sexes may be easily distinguished, for, with rare exceptions, the males carry the fecundated ova. Contrary to what generally happens, the females have lost the primitive organization of the generative organs, while the males have been more conservative. For elaborated details on this, as on various other points, the author refers to his 'Challenger' report.*

Dr. Hoek would place the larvæ of Pycnogonids with the primary larvæ of Prof. Balfour. When we consider the zoological position and classification of the Pycnogonida, we are led to the conclusion that the doctrine of Semper, which regards them as Arachnida, has nothing to defend it; the only real point of resemblance between them lies in their having the same number of thoracic appendages; the similarity in the formation of the first pair of appendages, lately dwelt upon by Balfour, seems to the author to be of less significance than the fact that this organ is innervated by a nerve arising from the sub-œsophageal ganglion. Dr. Hoek thinks that the Pycnogonida must form a distinct class of the Arthropoda, comparable to the Crustacea, Insecta, &c.

Starting from the protonymph, or larval form common to *Ascorhynchus*, *Nymphon*, and *Pycnogonum*, and noting that in the two former there remain appendages, which become cephalic, while in the last they are during development obliterated, we have to consider *Pycnogonum* as the least ancient form. The doctrine suggested by the history of the metamorphosis is supported by a study of the nervous system; in the primitive condition the ventral part of the nervous system is represented by six ganglia, excluding the more or less rudimentary abdominal ganglia; of the six segments corresponding to these ganglia, four are thoracic; and two, in a more primitive condition, belong to the cephalic part. As the mandibles are innervated by the subœsophageal ganglion, we have three pairs of cephalic appendages, and this is what is permanently seen in *Ascorhynchus* and *Nymphon*. This possession of three cephalic appendages is, by various evidence, indicated as the primitive arrangement. *Nymphon* retains this most unchanged, but the number of the joints in its cephalic appendages and the structure of the genital organs forbid us to regard it as the most ancient form now living. A hypothetical

* See this Journal, i. (1881) p. 886.

primitive form or *Archipycnogonum* might be defined as a Pycnogonid of large size, with strong mandibles of three joints, and armed with a terminal claw, with long palpi of ten joints, with ovigerous legs of ten joints, the last four of which are spinous. The thoracic limbs have eight joints, and end in a claw, with two accessory claws. The descendants of this form are either delicate and have their limbs articulated at a considerable distance from one another, or they are robust and their limbs are set close to one another. Four natural families may be distinguished—Nymphonidæ, Ascorhynchidæ, Colossendeidæ, and Phoxichilidæ—by the aid of the differences exhibited in the structure of the appendages.

Spiders' Webs.*—Mr. R. J. Lecky, referring to the discussion at the January meeting of the Society (*ante*, pp. 142–3), writes:—"The geometric spider never spins a glutinous web; the entire net is first made, beginning with the long stays (those alone suitable for optical purposes), then those at the circumference, next the radial threads, finishing the net with the spiral 'ratlins' (to use a nautical expression). When these are complete, the spinner begins at the 'ratlin' next to the exterior threads, and bedews them at regular intervals with the glutinous fluid, walking round and round until all is complete. This fluid spreads, in time, over the 'ratlins,' and so the thread appears as if spun in a glutinous state at the commencement."

δ. Crustacea.

Limulus a Crustacean.†—Dr. A. S. Packard, jun., who has also devoted much attention to this form, replies to Professor Lankester's paper on the Arachnid nature of *Limulus*,‡ maintaining that his conclusions are untenable. The criticism is not susceptible of abstract beyond the statement that Dr. Packard considers Professor Lankester has not correctly described the differences between the brain and the thoracic ganglionic mass of the scorpion and *Limulus*, that in the morphology of the brain the latter much more nearly approaches *Apus* and other Phyllopods than Arachnids, that four of the six segments described by Professor Lankester between the sixth abdominal segment and the spine are imaginary, as is also his view that the scattered simple eyes of the scorpion are really compound eyes, and some attempts to homologize parts of the scorpion with *Limulus*.

Segmental Organs in Isopoda.‡—Lereboulet in 1850 concluded that the Cloportides (Wood-lice) are allied to the Spiders, by the existence of special glands, secreting a silky substance; but M. Huet considers that the facts he has observed would equally enable them to be referred to the Annelida or Myriapoda.

There are glandular organs not only in the caudal region of these animals, but in each of the seven segments of the body. They are absent from the head. They open in the superior portion of the

* Engl. Mech., xxxiv. (1882) p. 496.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 369–74.
‡ Comptes Rendus, xciv. (1882) pp. 810–11.

epimera, on each side, in a sieve-like aperture. In the tail, the reduced segments do not show the "sieves," the glands undergoing a sort of concentration, and all opening together in a slit pierced with holes arranged in linear series. This slit is on the external side of the external urostyle.

Each of these glands consists of cellular elements of comparatively gigantic dimensions, some of them measuring 0·2 mm. Each is composed of a knobbed, indented, lobate body, *always* enclosing two large, symmetrical, granular nuclei, close to one another. Each nucleus contains a nucleolus, also very granular. The nuclei are coloured red by carmine, and blue by iodized serum. Between them winds a sort of vestibule, from which issues a canal, filled with the secreted substance. The canals do not anastomose, but end separately in one of the sieve-like apertures, or in the slit of the urostyles.

This arrangement is found in the greater part of the terrestrial Isopoda, *Porcellio scaber*, *Oniscus murarius*, *Armadillo*, and *Ligia*. *Porcellio pictus* has only the caudal glands. It is not found in any aquatic Isopod, nor in *Ligia oceanica*, nor in *Anilocra*, *Idoteidæ*, or *Asellus aquaticus*.

Bopyridæ.*—R. Walz deals in order with the different parts of the organization of these parasitic Crustacea; the cuticle of the male is said to be thicker than that of the female; the larval stages do not differ from one another in any important particulars; the changes early undergone by the mouth-organs are noted; later on, the oral cone calls to mind the suctorial proboscis of some Siphonostomata. On the inner side of the base of the first five pair of legs are developed the brood-lamellæ, which acquire their full size when the female reaches maturity; they are always membranous, and their chitinous cuticle is produced, as a rule, into short denticles. Varying a good deal in form, they determine that of the brood-pouch. The gills are thin, lobate, rarely tubular appendages; they always decrease in size from before backwards, and are, as a rule, better developed in the female than in the male; in the latter, indeed, they are often nothing more than small protuberances on the abdomen which disappear with age. Each lamella consists of two folds with a very narrow intermediate space; from one wall there pass to the other supporting bars, which have a homogeneous clear appearance and are to be regarded as cuticular structures. The digestive apparatus exhibits special characters, in correspondence with the parasitic habits of its possessors; the fore-gut is first enlarged and then narrowed to a tube; it leads into a wider portion, and the whole is so arranged as to act as a suctorial pump. The fore-stomach is enlarged into a crop, and the inner wall of some forms is provided with a number of processes, by means of which there is a considerable increase of surface; but this peculiarly arranged crop is, it is curious to note, found only in the female and not in the male, where the corresponding region forms but a very slight enlargement. The mid-gut likewise is much smaller and narrower in the male than in the female. The salivary glands which have been described by Cornalia and Panceri,

* Claus' Arbeiten, iv. (1882) pp. 125–200 (4 pls.).

were not detected by the author. There is a pair of hepatic tubes which give rise to numerous enlargements and lobes, but no lateral enlargements are to be found in the males.

There is a well-developed heart in the form of a rounded oviform sac; in the irregularly developed female there is to be detected not only an asymmetry of form, but also of the position of the clefts. The wall of the aorta is formed by a clear transparent membrane, which never exhibits contractions; though efferent vessels are present, there are no afferent ones; a septum of connective tissue extends transversely below the enteron, just as in the Phronimida.

The nervous system has only been examined by Rathke, and by Cornalia and Panceri; in its morphological relations it differs completely from that of the other Isopoda; the brain is extremely reduced, as are all the parts connected therewith; in the third thoracic segment is a reduced unpaired ganglionic chain, formed by the shortening of the longitudinal commissures and the fusion of the ganglia; in this seven distinct elements may be made out. The peripheral nerve-trunks have a somewhat peculiar ganglionic relation. Those of the first go directly from their proper ganglion to the most anterior thoracic segment; the second pair passes below the third ganglion, and the next near the sixth, or, in other words, just in front of the termination of the nervous plate. The sensory organs are either a great deal reduced or have completely disappeared; in the young free-swimming male there are eye-spots and jointed, paired, antennæ; there is some question as to whether eyes can be said to exist in the female; at any rate true optic nerve-fibres are not always to be made out. The larvæ have reddish pigment-specks at the sides of the cephalic lobes, which are covered over by the base of the outermost pair of antennæ.

Not only do these parasites retain a separation of the sexes, but there is a well-marked sexual dimorphism; the ovaries are dorsally-placed tubes, not fused with one another, the appearance of which varies with the age and condition of the animal; at first they are straight, but they gradually become provided with a number of lateral saccular diverticula, which project into the thoracic segments; the orifices of these organs are found, as might be expected, on the inner side of the bases of the fifth pair of legs. The wall of the ovarian tube is a thin membrane, invested internally by an epithelium and completely transparent. The male organs have much the same general characters as the female; and the tube functions both as germinal gland and receptacle for the sperm; the spermatozoa are very small granules, immense numbers of which are collected into one mass. No formation of spermatophores, or any copulatory organs have been detected.

After referring to the musculature and the connective tissue, the author passes to the second part of his essay, where he deals with the classification of the Bopyridæ: owing to the small number of species it is not necessary to form any subfamilies; the difficulties of definition lie in the fact that the form of the body, the number of antennary joints, and the arrangement of the gills differ so much in the two sexes.

Vermes.

Peculiar mode of Copulation in Marine Dendrocœla.*—Claparède has already shown that in the genus *Thysanozoon* there are two penes and two male genital orifices, but only one orifice in the female. This observation has not only been confirmed by A. Lang, but much extended; he having found at Naples forms with nine or even fifteen penes. It is obvious that these could hardly have been intended to be introduced into the single vagina. The true signification of the contrivance was elucidated by the observation of the copulatory process in several species of *Proceros*—the penis was thrust indiscriminately into the body of the female, and through the wound thus formed the semen flowed into the oviduct which is distributed throughout the body. The female organ therefore serves only as an exit for the eggs.

Classification of the Nematohelminthes.†—Dr. L. Orley proposes to establish three suborders, to which he would give the names of Nematentozoa, Rhabditiformæ, and Anguillulidæ; the last are fitted for a free life, and are characterized therefore by the presence of circumoral bristles, lateral circular markings, and a caudal sucker; the Rhabditiformæ are intermediate, for, while they lack the characters just mentioned, they resemble the free-living and differ from the parasitic Nematentozoa in having a thin cuticle, and a single straight tube, as well as in the fact that their nervous system is either entirely absent, or consists only of a few fibres. So, again, while all Nematoids have free larvæ, those of the parasitic group perish unless they enter a host; the Anguillulidæ do not so enter, but develope in mould or water, while the Rhabditidæ may or may not enter into hosts. There is an arrangement of the genera, with short diagnoses, and two new species of *Filaria*, *F. spiralis* and *F. ecaudata*, are described.

Relations of the Platyhelminthes.‡—Dr. A. Lang gives an account of the results to which he has been chiefly led by his study of *Gunda segmentata*.§ Considering first of all the Polyclades as creeping Ctenophores, he points out that, in his opinion, the *Cœloplana* of Kowalevsky is not intermediate between the Ctenophora and Planaria, but is a true creeping Ctenophore; this form is remarkable for being flattened, for having the ctenophoral plates absent, and for a complete investment of cilia. The fact that external conditions can produce such great changes prevents us from giving any importance to such characters as these, when we compare the two groups. To most of the internal points of resemblance between them attention has already been directed; but with regard to the development, we may note that Selenka has lately pointed out the striking similarity he has found in the earlier stages; and the observations of Lang are confirmatory of the fact that the embryo of the Polyclades is at first radial, and that it is only later that it becomes bilaterally symmetrical.

* Arch. Sci. Phys. et Nat., vi. (1881) p. 308.
† Ann. and Mag. Nat. Hist., ix. (1882) pp. 301–18.
‡ Arch. de Biol., ii. pp. 533–52.
§ See this Journal, *ante*, p. 197.

It is pointed out that *G. segmentata* presents many features of striking resemblance to certain Hirudinea, and especially the *Rhyncobdellidæ*; the pharynx, like that of the Triclades, is contained in a special cavity; the intestine has always a number of paired diverticula, the number of which is constant for a given species. The two last are always longer than the others, and often have, on their outer side, secondary outgrowths. These may be compared to the lateral and posterior branches of the intestine of the Triclades. The terminal intestine, the posterior dorsal anus, and the large sucker are to be regarded as formations special to the Hirudinea.

There is likewise a considerable resemblance as regards the excretory system, but the collecting organ of the Hirudinea is, again, a new formation; in the adult leech there is no connection, as we know, between the excretory system and the enteric diverticula, but in the embryos of *Clepsine* there is evidence that this system is developed from the epithelium of these diverticula. Striking resemblances are also to be seen in the generative system. The ventral ganglionic chain of the Hirudinea does not appear to be so very different, if we suppose that it is comparable to the two longitudinal nerve-trunks of *Gunda* connected at segmental intervals by simple commissures.

The musculature of the Hirudinea is mesenchymatous; the unicellular muscular fibres consist of an axial substance with a nucleus and a contractile sheath, just as in *Gunda* there is a dorsal musculature consisting of an external layer of transverse muscles, and an internal one of longitudinal fibres. In addition, there are dorso-ventral muscles which cannot be distinguished from the muscular dissepiments of *Gunda*, and, just as in that form, there is no enteric muscular layer. The body-cavity of the Hirudinea is not an enterocœle, but a schizocœle, formed by the vascular and lymphatic systems which are in communication with one another, and are developed, as Prof. Lankester has shown, by the liquefaction of the parenchymatous cells of the mesenchyma. Were the diverticula of the intestine to be detached from it, we should have a true enterocœle, which would then give rise to the epithelial musculature of the wall of the body and of the intestine, the excretory organs would thus acquire their primitive relations to the diverticula, and would serve, at the same time, for the evacuation of the generative products. It is probably along some such lines as these that the Oligochæta and Annelids have been developed from a Leech-like form.

In connection with this subject Dr. C. Chun * points out that, though there are several points in common, there are also some important differences in the development of the Ctenophora and marine Planaria. In both there are four small and four large cleavage-spheres, and the gastrula is formed by epiboly. While, however, the rapidly multiplying small cells of the Ctenophora represent the rudiments of the ectoderm and mesoderm, in the Planaria there arise four primitive mesodermal cells, which alone form the mesoderm. He is not certain that the resemblances point

* Biol. Centralbl., ii. (1882) pp. 5–16.

to genetic relationships, and suggests that these observations may only be the commencement of the raising of a new set of problems.

Entozoa confounded with Trichinæ.*—P. Mégnin points out that *Trichina spiralis* is not the only worm which may become encysted in the peritoneum or the muscles; and after showing how various naturalists have been led to speak of Trichinæ where none exist, he gives an exact account of the character of *T. spiralis.* It is an extremely delicate, filiform worm, with a very narrow anterior extremity, in the centre of which is the small round mouth; the posterior end is truncated, and has the anus in its centre. The intestinal tube is straight, and has a distinct œsophagus, stomach, and rectum. The agamic encysted forms are chiefly found in the muscles of animal life, but they are sometimes to be seen in the adipose tissue and in the muscles of the intestinal walls. Around the spherical space occupied by each coil, there is a deposit of colourless granular matter, which is more abundant towards the two poles, and has generally an elongated conical form. A single cyst or capsule rarely contains more than one worm. Later on, the walls of the cysts become incrusted with calcareous salts, within which the *Trichina* may continue to lie. After its death fatty degeneration occurs.

The European mole is often in spring infested, on the external surface of its stomach and intestines, with small cysts, in which a worm is coiled up. The integument of this parasite is markedly striated, the mouth has a papilla, and the body is more cylindrical than that of *Trichina;* in addition to these and other characters there is a conical tail. This is the larval stage of *Spiroptera strumosa.* In some Spanish and other lizards there may often be found a number of cysts scattered throughout the body; here again the anatomical characters are those of *Spiroptera* rather than of *Trichina;* and, in fact, the organism is *S. abbreviata.* Other forms from other animals, including the frog, are described; one belongs to the genus *Dispharagus,* all the rest to *Spiroptera.* The author justly points out that a careful comparative study should be made on all occasions when it is stated, or believed by the observer, that he has to do with the genus *Trichina.* The paper will be very useful to all who are engaged in researches of this kind.

Life-History of the Liver Fluke.†—Professor R. Leuckart states that his search for the young of *Distomum hepaticum* has at last been rewarded; specimens of what he regarded as *Limnæus minutus* were obtained from Dresden, and many of these were, after a few days, found to have in their respiratory cavity, and generally, near the kidney, a number of the embryos with which he had in vain attempted to infect larger snails. More or less rounded bodies were found more or less closely packed together, and attached by a delicate cellular envelope to the operculum; there could be no doubt as to the relation of the parasite to the embryo, not only was there

* Bull. Soc. Zool. France, v. (1881) pp. 189–98 (2 pls.).
† Arch. f. Naturgesch., xlviii. (1882) pp. 80–119 (1 pl.).

the characteristic cephalic process, but the simple x-shaped eye-dot was converted into two irregular black dots, while the internal changes that were seen indicated a metamorphosis into the sporocyst stage.

When the embryo escapes from its shell it contains all its germ-cells, which occupy the hinder portion of the body-cavity, while the anterior half is filled with a granular mass, which may be looked upon as the rudimentary enteron. At this stage the embryo has, in its general structure, so striking a resemblance to the Orthonectida of Giard, that the author is of opinion that these forms, just like the Dicyemidæ, must be regarded as of the Trematode group; the fact that they never pass beyond an embryonic condition, even although they exhibit a complete differentiation of the sexes, need not cause much astonishment, if we reflect that the sexually mature entozoa of a large number of Invertebrates are, after all, to be morphologically referred to more or less developed larval forms; in addition to this, we may note that there is not really the difference which there is ordinarily supposed to be between the germ-cells of the Trematoda and the female generative products. After swimming actively about for some time, the embryo makes its way into a snail, and generally into the respiratory cavity. As a rule, the ciliated investment is now lost, and the two eyes become separated; the form of the body meanwhile ceases to be conical, and becomes more or less compressed. The loss of the cilia is, of course, the expression of the commencement of the parasitic life; before it begins the animal makes some powerful peristaltic movements, which loosen the cells. As soon as the animal has completely entered into a resting-period, a thin layer of clear cuticular substance is secreted around its outer surface; this forms a kind of cyst, which is perfectly adapted to the form and changes in form of the body. Increase in size chiefly affects the germinal cells, some of which rapidly, and others less rapidly, divide repeatedly, and give rise to larger cell-aggregates; this growth leads to the enteron being pushed forwards, till it forms a kind of inner cap for the cephalic end of the body, the eyes become altered in position, and the number of the refractive granules increases.

All the germinal cells, however, do not undergo division and further development, a large number remain in their earlier condition; so again, during the first days of parasitic life, a number of sporocysts die down; some of those that become further developed would seem to have the power of dividing; at any rate the increase in the size of these parasites is less an active than a passive phenomenon; it is the consequence merely of the regular growth of the germ-spheres, which reacts on the form of the embryo; the walls of the body now become thicker, and lose largely their power of contractility; the ciliated funnels would seem to disappear, and even the eyes become obscured; the last signs of the rudimentary enteron are now also lost. Some of the germ-spheres contained within the body begin to elongate, till they form tubes of some considerable size, presenting a specific internal and external organization and forming definite creatures. The inequality in the rate of development of the germs which was noted is now more distinctly manifested by the presence of organisms at very various stages of development. To the author's great astonishment he found that the products of the sporocyst were not *Distomata*, but *Rédiæ;* these, when free, are about 0·4–0·7 mm. long, but are capable of considerable contraction and extension; a head, median region, and tail-end may be distinguished; the two former are separated sharply from one another by a prominent encircling ridge, while the body is distinguished from the tail by two blunt projecting processes, developed from the ventral surface. The tail is bluntly conical. The lips surrounding the mouth serve as attaching organs. The organization of the *Rédia* presents very considerable resemblance to that of the embryos, the organs being only more strongly individualized and the elementary parts more distinct, in correspondence with the larger body and higher function. The encircling ridge may be looked upon as a kind of skeletal girdle, which serves as the point of attachment for the retractors of the head and pharynx. As to the mode of development of this *Rédia*, the author believes that it passes through a gastrula stage; though some points were made out, the history of the germ-spheres could not be followed. Here then, unfortunately, this part of the history comes to an end; luckily some other snails were obtained in which were found three *Rédiæ*; two of these contained Cercariæ, but a third had a tailless *Distomum* which is believed to have been a young *D. hepaticum.*

In conclusion, some remarks are made on the small Lymnæids which are believed to be the hosts.

Excretory Apparatus of Turbellaria.* — In continuing his studies,† P. Francotte points out that Hallez denies the existence of the excretory canals in the genus *Monocœlis*, while Schultze and others distinctly affirm their existence. The author has been able to confirm the latter doctrine, so far as it applies to the presence of these canals, but he has not been able to detect any communications with the outer world. On the other hand, he has discovered the presence of ciliated terminal infundibula, very similar to those of the Trematoda and Cestoda.

In dealing with the genus *Monocœlis*, it is, first of all, necessary to take for examination perfectly fresh specimens; there will then be seen a system of principal canals, fine secondary canaliculi which form a plexus throughout the whole, and vibratile infundibula united to the plexus by a canal. There are two pairs of principal canals on either side of the middle line, two external and two internal; these are united with one another by several anastomoses of the same size; the distinct walls are transparent and very hyaline, but no definite histological structure could be made out. At certain points there may be seen a long conical filiform cilium; the canals contain a transparent liquid in which are some small granulations. The secondary canaliculi arise from the ciliated infundibula and have a very delicate wall, of no distinct structure; they are best made out in the anterior

* Bull. Acad. R. Belg., iii. (1882) pp. 88–98.

† See this Journal, i. (1881) p. 460.

region; the infundibula are conical, and have, in optical section, a triangular form; the wall is here again transparent and hyaline. It is interesting and important to note that in sections of these worms, though prepared by different methods, no trace of the existing canals has yet been detected.

The Dendrocœla (as represented by *Polycœlis nigra*) would appear to be without the secondary canaliculi, the infundibula being connected with the principal by five canals. The principal canals here form a plexus and would seem to open to the exterior; the highly refractive wall here again appears to be without any definite structure. Throughout their whole extent there is a continuous vibratile line lining the canals. The infundibula are conical and their wall is formed by the walls of the canals into which they open, but the black pigment of the form examined prevented the author from seeing whether or not the canals are completely closed.

New Parasites.*—J. Fraipont describes some parasites of *Uromastix acanthinurus*. Only five *Tæniæ* are yet known from any of the Saurians; the new form, *T. alata*, has two aliform delicate expansions on the neck; the transparency of the joints allows of the easy detection of the two pairs of longitudinal canals belonging to the excretory system, which extend throughout the whole of the body. In the terminal segments there were detected a considerable number of eggs, with a thin but resistent membrane, and each containing a hexacanth embryo, surrounded by an embryonic envelope.

The presence of an *Echinorhynchus* is interesting as, apparently, no species of the genus has ever yet been found in a Saurian; the present species is called *E. uromasticis*. *Filaria candazei* is a new species found in the subcutaneous connective tissue and between the different muscles of the body; the female is much larger and longer than the male (100–120 mm.). The muscles are arranged on the polymyarian type. Special organs in the shape of four pairs of pediculated appendages bearing each two small papilliform growths on their free end, are arranged symmetrically on either side of the sheath of the penis.

Tube of Stephanoceros Eichornii.†—Mr. T. B. Rosseter, on severing the longitudinal muscles that extend down the peduncle (cutting the tail through close to the base), saw the *Stephanoceros* swim out of the tube at the oral orifice, leaving it intact, and thus confirming the view of Mr. Slack, as against that of Mr. Pritchard, that it is tubular and not a solid gelatinous mass. He considers it clear that "it is perfectly hollow: there is no attachment between the cell and the creature, and it is quite as independent of its cell as *Melicerta ringens* is of its cell." The dragging down of the upper portion of the tube is caused by the teeth of the tentacles overlapping the sides and not from attachment to the neck of the creature.

Mr. J. Badcock, however, considers that both parties are right in

* Bull. R. Acad. Belg., li. (1882) pp. 99–106.
† Sci.-Gossip, 1881, pp. 107–9 (6 figs.).

the view they have taken; for, as the result of his own observations, he finds that when young the tube is hollow, but when old the cavity becomes filled up with a mucous substance.

Echinodermata.

Structure of Pedicellariæ.*—A. Foettinger has examined the gemmiform pedicellariæ of *Sphærechinus granularis.* He finds that the three more or less ovoid glandular sacs which are formed on the stalks of these, are surrounded by the common epithelial membrane which invests the whole of the organ. They open to the exterior by an orifice at their superior extremity, and they alternate in position with the valves which form the head of the pedicellaria.

After decalcification by means of chromic acid, and staining with carmine, the following tissues can be seen on making a transverse section of a pedicellaria at the level of these glands; there is an external epithelium, containing a large number of pigment-corpuscles, a layer of connective fibrillæ which separates and unites the glandular sacs; these have an external layer of flattened muscular fibres, with an oval nucleus, and these fibres are arranged concentrically around the orifice of the gland; the contents of the sac vary greatly, being in some cases formed of a granular, and probably mucous, matter which contains refractive corpuscles which swell up under the action of water, and are, doubtless, modified nuclei; in other cases the substance is filamentous, but this is ascribed to the coagulating action of alcohol; this substance swells up considerably on contact with water, &c.; and this increase in volume, when it happens with an uninjured pedicellaria, must lead to the outpouring of the contained mucus. When certain transverse sections are made, the contents of the sac are seen to be constituted almost solely of protoplasm with nuclei and cell-walls more or less intact. In longitudinal sections some of the glands present a protoplasmic layer investing the base and the walls. The author would explain these facts by considering that the glandular sacs are primitively filled by a tissue formed of polyhedral cells, and making a compact mass. At a certain time these cells are converted into mucus, and this change goes on until all the external cells are affected by it.

The three valves which form the head of the gemmiform pedicellaria are pyriform in profile view, and ovoid from in front; the enveloping layer is merely epithelium; below it there is a layer of granular and fibrillar connective tissue, which is generally very delicate, but is abundant between the valves, and near their upper surface. Beneath this tissue we find a glandular sac, which is double above; at the peripheral extremity the two branches unite into a single canal. This glandular sac would also seem to have its primitive contents formed of a compact cellular tissue. *Echinus melo* and *Echinometra subangularis* have at the base of the head of their pedicellariæ organs which are very probably homologous with those found on the stalk of *S. granularis.* M. Foettinger has also examined the pedicellariæ of

* Arch. de Biol., ii. (1881) pp. 455–96 (3 pls.). Bull. Acad. R. Belg., ii. (1881) pp. 493–504.

Diadema setosum and *D. mexicanum*; these, which are about 2 mm. long, are club-shaped and end in a very short and delicate pedicle; they enclose three large elongated glands with an orifice at their upper end; the glands are closely applied to one another, but have superiorly, where they diminish in size, six separating cavities which may be looked on as the homologue of the head of the pedicellariæ of *S. granularis*. In *Mespilia globulus* the pedicellariæ are excessively small and very numerous. In *Strongylocentrotus lividus* and *S. drobachiensis* the gemmiform pedicellariæ have a stalk which has considerable resemblance to that of the ophiocephalous and tridactyle pedicellariæ. When we compare *S. granularis* with *Echinometra* and *Diadema* we find that in the first the glands and head are equally developed, that in the second the glands are rudimentary, and that in the third it is the head which is rudimentary.

The author, not having been able to make any original observations on living forms, accepts the views of Sladen, who was the first to direct pointed attention to this subject.

Circulating Apparatus of Starfishes.*—E. Perrier and J. Poirier, after noticing the accounts of earlier observers, in which there is a large amount of very perplexing contradiction, state that they find that the vascular apparatus described by Ludwig in the partition of the infrabrachial canals has no existence, that the partition is not continuous, but that it is reduced at certain points to a vertical lamella while at others it presents distinct foramina. The body adherent to the hydrophoral canal, where Ludwig sees a plexus of vessels and which he regards as being the heart, is (as Jourdain showed in 1867) nothing but a gland; the same has been shown to be the case in the common sea-urchin, and Koehler has found the same to be true for the Spatangidæ. As the Ophiuroidea present a similar structure, we may say that, in all Echinoderms, this so-called heart is a simple gland.

The system of lateral branches described by Hoffmann as arising from the infrabrachial canals, has been detected, but a different account is given of its relations. These lateral branches do not curve round the ambulacral pore, but pass straight to the edge of the ambulacral groove; what Hoffmann took for the second branch of the horse-shoe is a fresh canal, independent of and identical with the first; and these two canals pass, parallel to one another, to the edge of the arm; there they bifurcate and the two neighbouring branches together pass through a foramen between two contiguous ambulacral, and the adjacent adambulacral pieces. In these foramina the two branches unite to form a common branch, which opens directly into the general cavity. There is always a similar hole between two contiguous ambulacral pieces, so that the infrabrachial canals always communicate with the general cavity by as many holes as there are ambulacral pieces. The infrabrachial canals and the branches which they give off are, therefore, merely dependences of the general cavity, divided into two communicating parts by the

* Comptes Rendus, xciv. (1882) pp. 658–61.

tentacular canals, and the system of ambulacral pieces. These canals also present a mode of partition which is remarkably like what is found in the brachial cavity of the Comatulæ; this mode is alone found somewhat late in the Crinoids, and we see that there is, therefore, in them "an accidental character" which contrasts strongly with the almost absolute fixity of the relations of the ambulacral apparatus. "This last is the essential and dominant character in the organization of an Echinoderm." The authors also find that the integument of the infrabrachial canals is formed of small bipolar cells, the swollen portions of which are near the external surface.

Genital Passages of Asterias.*—S. Jourdain describes the presence of five vasculiform ducts, lying below and applied to the internal face of the dorsal integument, the sides of which form a pentagon. The angles of the pentagon point to the interradial septa, and a vessel, embracing each septum, establishes a continuity between the branches which correspond to the sides of the pentagon. This vasculiform pentagon was regarded by Tiedemann as a dorsal venous circle, but from each septum there are given off two branches which become connected with the appended genital glands, and they are the only ones which are given off from it. The author is of opinion that this pentagon has no relation to the proper vascular system. The vessels do not have the relations of blood-vessels, but they are in communication with the interior of the gland and its diverticula; in other words, they are disposed as the excretory canals. The vasculiform dorsal plexus varies in size with the activity of the genital glands, and its walls are provided with muscles, while the internal ciliated surface has a projecting fold of glandular tissue. At the point of attachment of the enlarged interradial septum, which corresponds to the madreporic plate, the ducts of the pentagon open into an elongated fusiform sac, which is invested in an elastic membrane containing muscular fibres. At the extremity of this sac there are two brownish pyriform bodies, which are in connection with the canals of the pentagon; these, with the sac and its projection, are what most writers have considered to be the heart. They are not so, but merely dilated continuations of the pentagon. The fusiform sac opens into a circum-oral ring, to which are attached small paired globular bodies, almost similar in histological structure to the pyriform bodies. An orifice, of extremely small size, and very difficult to detect, is to be found where the sac is continuous with the circum-oral ring; so that, *Asterias*, just as in Holothurians, the sperm and the ova are passed to the exterior by a pore in the circum-oral circlet, and not by interradial perforated plates.

E. Perrier and J. Poirier state,† however, that specimens of *Asterias glacialis*, alive and depositing ova, are seen to have their ova escaping by ten groups of small holes, set a little above each interradial angle; each group contains three to six orifices; in specimens that had been opened from the dorsal surface no ova were to be found

* Comptes Rendus, xciv. (1882) pp. 744–6.
† Ibid., pp. 891–2.

in the circular dorsal canal, or in the tubular pouch surrounding the hydrophoral canal; this pouch serves as a means of communication between the dorsal and ventral circular canals, and is really nothing more than one of the spaces formed by the peritoneal membrane, and enlarged; but neither it nor the dorsal canal have anything to do with the excretory apparatus of the generative system.

Cœlenterata.

Clavularia prolifera.*—After a description of this new Alcyonarian, G. v. Koch discusses the mode of connection of the buds with the trunk; he points out that it is a remarkable fact that these buds are not mere outpushings of the body-wall of the mother-polyps, but that at the base of each bud there is a canalicular network in the thickened connective substance of the mother, by which the two polyp-cavities indirectly communicate with one another. Discussing the question of its origin, the author shows that, if it is secondary, or if, in other words, the young polyp first developes as a simple evagination, and gives rise to the plexus by a partial fusion of the intermediate substance, it would be a structure which owed its existence to adaptation, or had only a physiological significance, such as might be explained as due to the more or less complete isolation of the polyps. On the other hand, if it is primary, or, if it gave rise to the young bud, then we should have to seek its morphological significance, and might compare this canalicular network with the nutrient canals of the Gorgonida.

This important question could not be decided on the preserved specimen which the author has examined, but a study of some allied forms shows that in this group of corals the digestive cavities of the buds never open directly into that of the mother, and that there are a series of intermediate stages from those in which the polyp-buds are derived from simple stolons, and those in which the stolons form canals in the thickened mesoderm, and those, lastly, in which the thin partition between the bud and the mother is perforated by small orifices. We may therefore conclude that the more or less incomplete separation seen in the Alcyonaria has a certain use, and that it is not an adaptive arrangement, but one which may be referred to the formation of the stolons; the canalicular network in the mesoderm of the mother-polyps, which lies at the base of the buds and connects them with the mother, is a stolon-formation (in its widest sense). And, further, we find that in the Alcyonaria asexual reproduction is never effected by division or direct gemmation, but always indirectly, or by stolons or structures homologous therewith.

A study of the new species throws some light on the horny sheaths of the spicules, and their relations to the ectoderm, for we find that the younger spicules are always invested in a protoplasmic nucleated sheath, which may also be frequently made out in older examples, where we find cells connected by pairs and having within

* Morph. Jahrbuch, vii. (1881) pp. 467–87 (2 pls.).

them the young spicule. The doctrine, then, of Kowalevsky, that the spicules arise from cellular elements, may probably be extended to all the Alcyonarians. And the same would seem to hold for the horny sheaths. These cells found in the mesoderm would seem to have been derived from the ectoderm, whence cells have been observed to wander into the middle layer; as this has never been noted with regard to the endodermal cells, we may conclude that the hard skeletal parts of the Alcyonaria, whether spicula or horny sheaths, are derived from the ectoderm.

Porifera.

Sponges of the Gulf of Triest.*—In his second paper on the marine fauna of the Gulf of Triest, Dr. E. Graeffe deals with the Spongiariæ; with which O. Schmidt has already dealt. It is pointed out that sponges have but few enemies; some of the species of *Doris*, *Doriopsis*, and *Fissurella* attack their outer layers; on the other hand, they have a number of parasites, Algæ and Chætopod Annelids being the most conspicuous. *Gammarida* are also not unfrequently found. Some silicious sponges have their outer surface affected by small Aphroditeidæ and by Hydroid Polyps.

In the list given by the author especial attention is directed to the places in which they are found, and their time of reproduction, with some notes on the localities of the ova and larvæ.

Spongiophaga in Fresh-water Sponges.†—Mr. E. Potts insists that Mr. Carter is mistaken in considering that the slender curling or twisted tendrils ‡ of the statosphere of fresh-water sponges of the genus *Carterella* § are parasites, as described by him under the name of *Spongiophaga Pottsi*.‖ Prof. Leidy, by whom they were examined, says that " there can be no question as to the tendrils being part of the structure of the statoblast—homogeneous extensions of its inner capsule."

The function of the tendrils is apparently to meet the emergency occasioned by the looseness of the skeleton structure, from which the sarcode-flesh dying early washes away, most of the spicules soon following in the winter floods. The eggs are thus left to the protection of the tendrils, which lap them together, bind them to the remaining spicules or the roots of water-weeds or shore-plants, or assuming the rôle of the hair which the plasterer uses, bind the deposited silt about them, and both to the stones, where they await the appointed time for a new growth. The resemblance in material structure of these tendrils to that of the specialized hooks of some of the Polyzoa is very striking.

Mr. Carter, as the result of subsequent examinations,¶ agrees with Mr. Potts' view as to the filaments being in reality cirrous appendages on the statoblasts and not Spongiophaga.

* Claus' Arbeit., iv. (1882) pp. 313–21.
† Proc. Acad. Nat. Sci. Philad., 1881, pp. 460–3.
‡ See this Journal, i. (1881) p. 613.
§ Ibid., p. 901. ‖ Ibid., p. 901.
¶ Ann. and Mag. Nat. Hist., ix. (1882) pp. 390–6.

New Fresh-water Sponges.* — Mr. E. Potts describes three more curious fresh-water sponges. One (*Meyenia crateriforma*) is of a very delicate structure; its framework of skeleton spicules is exceedingly meagre, and slightly bound together, scarcely amounting to a mesh system, and the numerous small white statospheres are found in recesses far larger than themselves. Another (*Heteromeyenia ryderii*) forms beautiful green masses, often four to five inches in diameter, and about a quarter of an inch in thickness. The surface is irregular, occasionally rising into rounded lobes; the efferent canals are deeply channelled in the upper surface of the sponge, five or six sometimes converging to a common orifice. The statospheres are numerous and rather small. There are two series of birotulate spicules. The third species belongs to the genus *Tubella*. This genus, established by Carter, contained only four species, all from the Amazon river. The new species is small, encrusting, and has been named *T. pennsylvanica*. The skeleton spicules are arranged in a simple series of single non-fasciculated spicules, in the interspaces of which the statospheres are abundant. These spicules are very variable in size and shape, but all are entirely and coarsely spined. The dermal spicules seem absent.

Protozoa.

Organization of the Cilio-flagellata.†—R. S. Bergh gives an account of the Cilio-flagellata observed in the Little Belt and in the fresh waters of Denmark; the first part containing "History" and "Bibliography," the second a description of ten genera and twenty species, and the third Phylogeny. The chemical composition of the various parts of the body is fully dealt with so far as that is possible by the use of reagents, as well as the anatomical structure. Seventy-three figures show what great variation is presented by certain forms, and how difficult it often is to define the limits of the species.

The *body* of all Cilio-flagellata is bilaterally asymmetrical, differing remarkably, however, in the various representatives; sometimes it is compressed from front to back (*Diplopsalis lenticula*, *Glenodinium Warmingii*), sometimes from above downwards (*Ceratium*, *Peridinium*), and sometimes laterally (*Dinophysis*, *Amphidinium*, *Prorocentrum*). It may be drawn out into horns (*Ceratium*, *Peridinium divergens*) or may be destitute of any.

They possess either a lorica (cell-membrane) (*Ceratium*, *Protoceratium*, *Peridinium*, *Protoperidinium*, *Dinophysis*, *Diplopsalis*, *Glenodinium*, *Prorocentrum*), or are naked (*Gymnodinium*, *Polykrikos*). The *membrane* consists either of cellulose or a similar hydro-carbon, and is coloured by chlor-iodide of zinc, pale violet (*Ceratium*, *Perid. tabulatum*) or intense red (*Perid. divergens*, *Protoperidinium*, *Diplopsalis*), or even pale red (*Prorocentrum*, *Glenodinium cinctum*). Those forms which have been closely examined do not contain silica. The more minute structure of the cell-membrane varies much; it is either transparent and structureless (*Glenodinium*) or ornamented with

* Proc. Acad. Nat. Sci. Phila., 1882, p. 12.

† Morph. Jahrbuch, vii. (1881) pp. 177–288 (5 pls. and 1 fig.).

reticulately arranged ridges (*Ceratium cornutum*, and *C. hirundinella*, *Dinophysis*), or the ridges do not form a network, but run more irregularly, pores also appearing (*Ceratium tripos*, *C. furca*, *C. fusus*); finally we find a division by bands into a number of plates of various sizes with smaller intermediate striæ, so that the plates show the reticulated structure, the bands on the contrary being transversely marked (*Peridinium*, *Protoperidinium*, *Diplopsalis*); in *Prorocentrum* (apparently) the membrane consists of two cuirasses, which are perforated with fine pores.

The *protoplasm* is apparently always separated into ectoplasm and endoplasm, which both show very varying differentiation. In the cuirassed forms the ectoplasm is always quite structureless and homogeneous; in *Gymnodinium* and *Polykrikos*, the most highly developed forms, it shows many peculiarities; in *G. gracile* it is very much wrinkled and folded, and in *G. spirale* it contains muscular fibrillæ in its inner layers; in *Polykrikos* trichocysts are developed in it. The endoplasm sometimes contains, at the same time, chlorophyll, and diatomin and starch, or some similar amylaceous matter (*Ceratium*, *Protoceratium*, *Perid. tabulatum*, *Protoperid. Michaelis*, *Glenodinium*, *Dinophysis acuta*, *Prorocentrum*), which indicates a mode of nutrition similar to that of plants; sometimes these substances are wanting, and the body contains digested organisms (*Gymnodinium*, *Polykrikos*), which indicates that alimentation takes place as in animals; finally, there seem to be some forms which are nourished neither by the agency of chlorophyll (the assimilation of carbonic acid) nor by animal matter, as we find in their endoplasm neither the above-mentioned colouring matter nor foreign organisms (as in *Protoperid. pellucidum*, *Perid. divergens*, *Diplopsalis lenticula*, *Dinophysis lævis*). The endoplasm in *Perid. divergens*, *Diplopsalis lenticula*, &c., is coloured slightly red; in the former it usually contains little drops of red-coloured oil. No contractile vesicle can be pointed out with certainty. In all the forms in which the nutrition could not be seen to be either assimilative or purely animal, a vesicle is found which often communicates with the outer world through the flagellum-furrow and a narrow canal, but is sometimes separated from it; probably its function is to take in sea-water (with nourishment).

The *nucleus* is generally single; only in *Polykrikos* we find four (larger) nuclei. Those of the Dinifera consist of a fine granular substance containing no nucleoli and colouring bright pink when treated with picrocarmine (after alcohol). Only in *Polykrikos* is there found a second sort of smaller nucleus (perhaps "primary nucleus" in the same sense as in the Ciliata). The nucleus of *Prorocentrum* still needs a closer examination.

The *locomotor apparatus*, the special characteristic of the Cilioflagellata, consists of long, powerful flagella and smaller cilia. These *cilia* spring either directly from the anterior end of the body (*Prorocentrum*), or are arranged in one or two contractile rows in a transverse furrow formed by two projecting plates or ridges (Dinifera). The furrow lies either at the anterior extremity of the body (*Dinophysis*, *Amphidinium*), or about the middle (the other forms); in *Gymnodinium* *spirale* it is spirally twisted. The ciliary movement seems to go in one constant direction, beginning on the left of the ventral surface. In *Gymnodinium* there appears to be only one contractile row in the furrow. In *Polykrikos* there are eight furrows independent of each other. The edges of these furrows are interrupted on the ventral side; the posterior ones continue in a peculiar system of horns and ridges, which are either placed close on each other, as on the small ventral side of *Dinophysis*, or are separated from each other as a right and left hand division (*Protoperidinium*); this entire apparatus serves for limiting the longitudinal furrow. In the other forms either the horns alone persist (*Peridinium*), or the ridges (*Diplopsalis*, *Glenodinium*), or both are absent (*Ceratium*, *Gymnodinium*.) The *Flagellum* is inserted either through a wide ventral aperture in the membrane (*Ceratium*) or through a narrow fissure in the longitudinal furrow, either at the anterior pole (*Prorocentrum*) or the posterior pole (*Amphidinium*, according to Claparède and Lachmann) or in their neighbourhood.

Of the *propagation and development* of the Cilio-flagellata little is known with certainty. We find fission as well as conjugation. Transverse fission results either in a free-swimming animalcule (as for example in *Polykrikos*, in Allman's *Perid. uberrimum*), or in withdrawal into the old membrane (*Perid. tabulatum*), or finally in certain cysts, which are either round (*Glenodinium cinctum*, *Gymnodinium* according to Stein) or have peculiar, strange (horned) forms (*Perid. tabulatum* according to Stein). Conjugation is especially shown by Stein in *Gymnodinium pulvisculus;* but several of his statements, the author thinks, require a complete revision.

Under the head of "Phylogeny" the author endeavours to unravel the relationship of the organisms, even for each genus and species. The results of such an attempt could not be very definite, for, as he himself says, we have not the necessary palæontological evidences and consequently the intermediate forms are wanting that have existed in past times. The author's six genealogical trees can therefore only be taken for what they are worth, that is as a representation of the more or less intimate relation which we can recognize between certain forms. It is, however, a clever and convenient method of expressing one's views of the affinities.*

According to the author, the Flagellata form a point of departure from which are developed phylogenetically (diverging on different sides), the *Noctilucæ*, Rhizopoda and Cilio-flagellata. The oldest forms of Cilio-flagellata were the Adinida, of which only one living species (*Prorocentrum*) is now known. They acquired small cilia, and a bilaterally asymmetrical form. There later appeared the ciliary apparatus, at first posteriorly and then anteriorly limited by the ridges of the membrane, so that a transverse furrow was formed (Dinifera) which was originally on the anterior margin (*Dinophysis*, *Amphidinium*); then the flagellum was removed from its primary position posteriorly, whereby a longitudinal furrow was formed, at first confined by a complicated apparatus of ridges and horns. Still

* Cf. Arch. Sci. Phys. et Nat., vi. (1881) pp. 402-4.

later the body became rounded, the transverse furrow moved in a posterior direction, and the membrane acquired plates, whilst the longitudinal furrow-apparatus remained entire (*Protoperidinium*). From this point began the development in two directions, since on one side the ridges (*Peridinium*, *Protoceratium*, *Ceratium*) and on the other the horn-like processes of the longitudinal furrow (*Diplopsaria*, *Glenodinium*) were reduced, and finally the plates coalesced. The highest division is represented by the Gymnodinida in which subfamily the membrane is quite abolished, and numerous differentiations of the protoplasm developed. Finally, springing from these, are forms in which the flagellum is reduced, but in which a cytostom and cytopyge are differentiated in order to give origin to the Peritricha, the oldest ciliated Infusoria (*Mesodinium*).

L. Maggi * establishes the occurrence of *Ceratium furca* Ehrenberg, hitherto almost exclusively known as marine, in certain lakes of Upper Italy (Lago di Candia, near Ivrea, and Lago di Annone, in Brianza); at the same time he devotes much attention to the synonymy of this species and to the history of the investigations into the phosphorescent powers of the *Ceratia*. Like Claparède and Lachmann, he regards *Peridinium lineatum* as identical with *Ceratium furca*. The form was not observed alive, but only the remains of its tests; among these occurred in the Lago di Candia, a considerable number somewhat differently shaped, which the author thinks right to constitute a special variety, under the name *lacustris*.

The same writer † gives a list of all the Cilio-flagellata known to him through literature or by original observation, adding the synonyms and habitats of each form. He retains the following five genera:—*Ceratium* (with seventeen species, two of which are fossil), *Peridinium* (with thirty species, all recent, two fossil ones also occur), *Dinophysis* (seven species), *Amphidinium* (one species) and *Prorocentrum* (one species). He believes that Claparède and Lachmann have gone too far in their reduction of the number of the species, and have allowed themselves to be guided by reasons which will not bear investigation. He endeavours to show here, as in another place, that the Cilio-flagellata were originally derived from the sea, in which even at the present time they attain so great an importance, and have only later extended into fresh water. By this means the circumstance is explained of their inhabiting more particularly the larger fresh-water lakes, for in these are found conditions resembling to a certain extent those of the sea. On this view Prof. O. Bütschli ‡ remarks that the author has not paid attention to Stein's writings on the Cilio-flagellata, or he would have seen that Stein distinguishes three additional genera, *Gymnodinium*, *Hemidinium*, and *Glenodinium*, but is inclined to remove the genus *Prorocentrum* from the group.

L. Maggi § further arranges together all the Cilio-flagellata known

* Bollet. Scientif., i. (1880) pp. 125–8. Cf. Zool. Jahresber. Neapel for 1880, i. p. 167.

† Op. cit., ii. (1880) pp. 7–16. Cf. tom. cit., p. 167.

‡ Tom. cit., p. 167.

§ Rendic. R. Istit. Lombard. xiii. (1880) p. 20. Cf. Zool. Jahresber. Neapel, tom. cit., pp. 167–8.

to him through the literature of the subject, according to their mode of occurrence. Thus the forms hitherto found in the different seas are enumerated, after which a catalogue is given of those belonging to fresh water, according to the manner of their occurrence in lakes, marshes, streams, ditches, &c.; and finally a list of those forms which have been hitherto found in both sea and fresh water. These last include four forms, viz. *Ceratium tripos* Ehrb., *furca* Ehrb., *Peridinium spiniferum* Clap. and Lachm. (according to Maggi's observations), and *Prorocentrum micans* Ehrb. The paper concludes with an enumeration of the known fresh-water forms, arranged according to the different countries in which they occur, and going so far as to give for each form the particular locality in which observers had met with it. From this section may be specially selected the fact that the author records *Peridinium pulvisculus*, Ehrb., *spiniferum* Clap. and Lachm., *tabulatum* Schm., as well as *Ceratium longicorne* Perty, as found by him in Upper Italy. It is unnecessary to go more fully into Maggi's results, as he has made no attempt to examine closely and compare the forms described by various writers, in order to decide their claims, but contents himself with simply enumerating them.

Infusorian with Spicular Skeleton.*—R. S. Bergh has obtained large quantities of the Infusorian described by Claparède and Lachmann under the name *Coleps fusus*, in the open sea off the Small Belt (Denmark). The peculiarities which he has observed in this species appear to him sufficient to raise it to the rank of a new genus, whose principal character, distinguishing it from *Coleps*, is that the skeletal sheath is not a continuous fenestrated test, but consists of single disconnected spicules. These are parallel to the long axis of the animal, which has a considerable longitudinal extension and is pointed at the aboral pole; they are arranged in five transverse series, showing considerable differences between their heights. The spicules are provided with short lateral cross-branches, differing (but not constantly so) in number in the different series; they constitute an indication of reticulate structure, but, as already stated, they are not so much developed as to unite the spicules together. The spicule-elements of the skeleton consist of an organic substance, and lie imbedded in the peripheral protoplasmic layer. The cilia are placed above, not between them. A compact crown of cilia is found at the oral pole. The simple, roundish nucleus lies within the middle series of spicules.

Contractile Vacuole of Vorticella.†—After an historical introduction relating to the controversy about the presence of a membrane to the contractile chamber, J. Limbach describes his own observations on the subject as follows:—In pathologically altered specimens of *Vorticellæ*, in which their characteristic ciliated organ is swollen up and the body is detached from the pedicel, the contractile vacuole

* Vidensk. Meddel. Naturh. Foren. Copenhagen, 1879–80, pp. 265–70, woodcuts. Cf. Zool. Jahresber. Neapel for 1880, i. p. 170.

† Kosmos, (Zeitschr. poln. Naturf. Ges. Kopernicus), 1880, pp. 213–21. Cf. Zool. Jahresber. Neapel for 1880, i. p. 169.

becomes more and more distended, so as to include as much as three-fourths of the breadth of the body. It is scarcely probable that an unusually thin membrane in connection with the vacuole, if present, should be able to stretch to such an extent, without bursting, a consideration which appears to furnish additional evidence in favour of the absence of a membranous wall in the vacuole. Limbach, by observation of *Vorticella cyathina* during fission, has been able to determine the opening of the vacuole into the vestibule, and the expulsion of its liquid through the opening of the latter. The same results were obtained from the abnormal *Vorticellæ* above mentioned. Thus the contractile vacuole constitutes an excretory organ, although it may at the same time assist in the function of respiration.

Geographical Distribution of Rhizopoda.*—C. Parona gives a review of the Rhizopoda found by Leidy in North America, of those met with at the same time in Europe, and finally of those found since then in Italy. The astonishing agreement in the Protozoan faunas of districts so widely separated prompts him to raise the question whether the laws of phylogenetic development are hereby modified, a question which he answers negatively. This agreement is explained, according to his view, by the original derivation of the Protozoan faunas of both regions from a common source, and this must undoubtedly have been a marine source.† The closely similar alterations which have taken place in the circumstances and manner of life which the primitive Protista-faunas of the two continents have undergone in the course of ages, are considered by the author to have gone so far as to cause even the development of closely similar forms. He is therefore inclined, at any rate in this case, to admit a polyphyletic origin of species.

Classification of the Gregarinida.‡—B. Gabriel puts forward in two places a new classification of this group, based on his investigations into the process of reproduction in the Gregarines. He has been led to take this course by finding the principles advanced up to the present time by Stein and Schneider, and depending essentially upon the morphological peculiarities of the mature forms, to be insufficient; he therefore believes that a classification can only be based on the reproductive relations of these organisms. The presence or absence of a septum (the point of distinction between Mono- and Polycystidæ of Stein and Schneider) has in his eyes no deep importance, inasmuch as he has found at Naples, in *Typton spongicola*, a Gregarine, which in its early life is a septum-less Monocystidean, but acquires later not only one, but numerous transverse septa, and thus presents a colonial or strobila-form which arises by terminal budding, and whose segments are individually capable of independent reproduction. Gabriel finds the attaching apparatus of

* Bollet. Scientif., ii. (1880) pp. 43–50. Cf. Zool. Jahresber. Neapel for 1880, i. p. 127.

† Prof. O. Bütschli (loc. cit.) remarks on this that this opinion might be extended with probable accuracy to all fresh-water faunas.

‡ Ber. Versamml. deutsch. Naturforscher u. Aerzte, 1880, pp. 82–3. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 160–1.

the Polycystideæ to have no greater importance, it being found similarly developed in Monocystideæ as well. The method of generation and development exhibits important variations both in the Mono- and Polycystideæ, and, indeed, is repeatedly found to be identical in members of both the groups. The author at first considered that the Gregarines should be broken up into two subdivisions, according as encystation occurs in the course of reproduction or does not; these were termed respectively *Acystoplasta* and *Cystoplasta*. He even found that in a Gregarine obtained from *Julus sabulosus* (and probably identical with *Stenocephalus Juli* Schn.), the spore-formation was completed without encystation, and without alteration of any kind in the shape of the body. He considers, however, this case not of sufficient importance to establish the above two subdivisions, and therefore distinguishes three divisions by the process of development and spore-formation; their characters may, however, be stated at the outset as difficult to understand, owing to the very indistinct preliminary notices in which the results of the author's developmental researches are presented. We give the characteristics of these three divisions as follows in the words of their author:—

"i. *Greg. Isoplastæ.*—The germs of the Gregarinæ and the series of the Myxomycetes appear at the same time, and both take their origin from the differentiated body-mass, but each for itself and independently one of the other. *Cystoplasta* represents Myxomycete forms by plasmodia.

"ii. *Greg. Proteroplastæ.*—The body-mass of the Gregarinæ, when generatively mature, becomes differentiated into a Myxomycete plasmodium. The Gregarine germs take their origin from this. *Acystoplasta.*

"iii. *Greg. Hysteroplastæ.*—The Gregarine germs first originate from the differentiated body-mass; the series of the Myxomycetes proceeds exclusively from certain transformations of the germs of the Gregarines (amœboid bodies). *Cystoplasta.* Myxomycete forms represented by plasmodia with radiating processes, pigments, calcareous corpuscles, and Mycetozoa."

The Myxomycete forms which produce psorospermiæ are regarded by the author as derived from disintegrated Proteroplasta, but the "sickle-shaped bodies found in Vertebrata and claimed as Gregarines by Eimer," on the other hand, as allied to the Hysteroplasta.

Psorospermiæ in Man.*—B. Grassi has found in the excrements of a boy and of a young man during a long period ($2\frac{1}{2}$ months in the first case) numerous bodies which after much hesitation he describes as oval Psorospermiæ (Coccidia). They exhibit a number of variations in size and form; they are sometimes globular, sometimes elliptical; in the first case they generally measure ·008 mm. in diameter, but in the latter usually ·008 to ·006 mm.; they have a distinct, and in the larger individuals a double-contoured test, and finely granular contents, completely filling the shell and containing

* Rendic. R. Istit. Lombard., iii. (1880) 3 pp. Cf. Zool. Jahresber. Neapel for 1880, i. p. 162.

from one to eight roundish nucleoid bodies. The contents may also be sometimes quite homogeneous or somewhat condensed and retracted from the test, and in many the protoplasm contained from one to six semilunar homogeneous glistening bodies, which, however, judging by the very poor figure given of them, show no special resemblance to the sickle-shaped bodies of Coccidia. The behaviour of these bodies towards various reagents and staining substances is also described. From all this the Coccidian character of these structures seems to be still doubtful. The two patients exhibited no complaints to which the presence in them of these parasites might be referred.

Myxosporidia.*—Under this term, which is introduced † by Professor O. Bütschli, may be mentioned the so-called parasitic plasmatic tubes of the pike's bladder, discovered by Lieberkühn, and belonging to the so-called Fish-Psorospermiæ, so widely distributed in these animals. According to Gabriel, they have no intimate connections with the Gregarinæ, as Leydig, and later Lieberkühn, have endeavoured to show; the following are the chief reasons which he advances for this opinion. These very variously shaped protoplasmic structures at no period of their life possess an envelope like that of Gregarinæ, and they are entirely non-nucleate. Moreover, the surface of the body frequently developes extensions and radiating processes of a very peculiar character, appearing now pointed, now finely fringed, sometimes hair-like and often branched as well, and consisting of protoplasm which is quite transparent, though not entirely without granules. These stellate processes cannot be directly compared to pseudopodia, for though they are protruded they are not retracted again. They consist "of what may be called a thread-drawing substance, which can issue forth with ease but cannot be again retracted." A substance of this nature is said to be peculiar to the protoplasm of Myxomycetes and to certain plasmodia resembling Myxomycetes, and connected with the development of true Gregarines. Real phenomena of motion have not however been observed by the author in these protoplasmic structures. A further argument against their Gregarine nature is the presence in them of a yellow pigment of various shades, pigment of which kind is frequently found in the Myxomycetes.

To what was known of the formation of the spores of the true Psorospermiæ which occur within the protoplasmic structures, Gabriel is hardly able to add anything. According to him, the spores are developed, as already stated by Leydig and Lieberkühn, in spaces or vacuoles which are at first unprovided with walls, and later, but not in all cases, become converted into vesicles by formation of a wall. The spores are formed within these vacuoles in a manner which is compared by the author to a process of secretion. Inasmuch as several spores may develope within a single vacuole, Gabriel terms the vacuoles "polysporogenetic centres of development," and sees in them a veritable contrast to the "single, monosporogenetic forms of

* Ber. naturw. Sect. Schles. Ges., 1879, pp. 26–33. Cf. Zool. Jahresber. Neapel for 1880, i. pp. 162–4.

† Op. cit., p. 162.

development" of the Gregarine germs (Pseudonavicellæ). Of the structure of the spores we learn almost nothing; in particular, the remarkable thread-cell-like structure of the so-called polar corpuscles appears to have quite escaped the author, and he takes no notice at all of Balbiani's work on the Psorospermiæ of fish. He has not been able to observe any bursting of the spores and emission of an amœboid body.

On the other hand, he has observed a method of development of the spores which is carried out inside the bladder, but which he gives with some reserve. It commences with the solution and absorption of the containing capsule, but then proceeds in two different ways. Either the central protoplasmic part of the spore fuses with the two polar corpuscles into a single protoplasmic mass, or the parts remain distinct. In the latter case the spore-contents are said to break up (in a manner which is not very intelligible) into two pieces, seldom more. Finally, spore-contents, which have become granular and vacuolated, are said to develope small, strongly granular plasmodia, which become the protoplasmic structures first described. The existence of another process of spore-development appears to the author to be certain, seeing that at some time or another infection must take place from outside. As already indicated, the author draws from his results the conclusion that the structures which we have been considering cannot be included with the Gregarinæ, but must be considered as "spore-forming Myxomycetoid plasmodia," not, however, exhibiting the entire characters of the group Myxomycetes. Hence they are to be regarded as a tribe whose systematic position lies between the Myxomycetes and Gregarines, a circumstance which appears to the author to have a most important bearing on the relations which he represents to exist between these two groups.

Morphology of Protozoa.—L. Maggi * again calls attention to the differentiation of a mesoplasm between the ecto- and endoplasm, a fact of deep importance in his view, and first discovered by him in certain Amœbæ and the genus *Podostoma*. The demarcation of these three regions in the protoplasm of the body of certain Protozoa appears to him of especial interest for this reason, that they exhibit an analogy with the three blastodermic layers of the Metazoa. The ectoplasm gives rise to the pseudopodia, which effect the relations with the outer world; on the other hand, the mesoplasm supplies the contractile vacuole, an organ of circulation, excretion, and exhalation; lastly, the entoplasm contains the "entoplasmatic organs," viz. the digestive cavity, the nucleus, and nucleolus, the two last being the organs of reproduction. Thus it is the mesoplasm and entoplasm which support the vegetative functions of life. Grimm also † has pronounced in favour of the view of the differentiation of a mesoplasm and drawn the same parallel with the germinal layers of the Metazoa.

G. Cattaneo ‡ expresses opinions with regard to the morphological

* Bollet. Scientif., i. (1880) pp. 81–3. Cf. Zool. Jahresber. Neapel for 1880, i. p. 123.

† 'Contributions to the Knowledge of the Simplest Animals,' 1877, in Russian.

‡ Atti Soc. Ital. Sci. Nat., xxii. (1880) p. 68 (2 pls.). Cf. Zool. Jahresber. Neapel, tom. cit., p. 123.

structure of plastids precisely similar to those propounded in 1879 by Maggi. In his view the protoplasm and plasson are made up of numerous simple albuminoid particles, which he agrees with Maggi in naming *plastidules* and which represent the simplest morphological elements. The simplest forms of these plastidules, the so-called *protoplastidules*, are said to be the granules devoid of independent motion which are found in organic infusions; with these may perhaps be ranked as structures of similar morphological value, the free solitary spherical Bacteria, the Cocci, and Micrococci. If these protoplastidules become differentiated in such a way as to form around themselves parts of unequal physiological values, there arise the *autoplastidules*, among which must be included the simple Microbacteria, such as *Bacterium termo*, the Monococci and Monobacteria of Billroth, the Desmobacteria (*Bacillus*), and the Spirobacteria (*Spirillum*). By colonial growth, on the other hand, the protoplastidules give rise to *symplastidules*, among which are placed the social forms of the Bacteria, as the Diplobacteria, the Strepto-, Glio-, and Petalobacteria, and also the Amphiasters (*Kernspindeln*), and stellate figures of cells in process of division. A combination of plastidules which are not all developed in the same way forms a *plastid*.

Differentiation generally takes place in a radiating manner, so that an outer and an inner mass are formed, differing somewhat from each other. The simpler forms are in this case the *protoplastids*, which include the non-nucleate gymno- and lepo-cytodes, and the simpler nucleate gymno- and lepo-cellulæ. By further differentiation these protoplastids result in *autoplastids*. The author considers that the different layers of differentiated substance in a highly developed autoplastid, viz. ecto-, meso-, entoplasm, nucleus, and nucleolus, may be compared to so many cytodes concentrically grouped; and thus an autoplastid of this kind is to be regarded anatomically (though not genetically) as a colony of cytodes.

The colonies of plastids are described as *symplastids*. The author includes among them the Gregarinæ.

Eozoon Canadense.*—Professors King and Rowney deal with the question of the organic nature of *Eozoon* and of simulation of organized structures generally, their opinion being decidedly in favour of its mineral origin.

In the first place they state that the "typical nummuline wall" is a pectinated form of chrysolite, due to modification of that allomorph of serpentine, where the fibres of the mineral ultimately become separated aciculæ with calcareous interpolations. The "canal system, &c.," is rather more obscure in its origin. It is frequently due to the peculiarities of a layer of flocculite (a non-fibrous allomorph of serpentine), which on undergoing some solvent or decreting process, is apt to be shaped into irregular configurations. So likewise the "chamber castes" of the acervuline variety are identical with the variously lobulated crystalloids characteristic of

* King and Rowney, 'An Old Chapter in the Geological Record with a New Interpretation; or, Rock Metamorphism and its Resultant Imitation of Organisms.' 8vo, Van Voorst, 1881. See Geol. Mag., ix. (1882) pp. 231–6.

Tyree "marble" and similar rocks, due, as the authors believe, to decretion of the original silicate. As regards the calcitic layer containing the "intermediate skeleton" in typical specimens of *Eozoon*, the calcite composing this part is "plainly a replacement pseudomorph after serpentine." This explanation would account for the alleged cases of "chambers" and "canal system" preserved in calcite.

BOTANY.

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

Chemical Difference between Dead and Living Protoplasm.—In the paper by Dr. O. Loew and T. Bokorny, noticed under the above heading at vol. i. (1881), pp. 906–7, it should have been stated in the description of the method employed for producing the reduction of silver by the protoplasm, that the silver nitrate solution must be used in an alkaline condition, produced by the addition of ammonia. Similarly, to obtain reactions with gold chloride and platinum chloride respectively, the previous addition of caustic soda to the solution of the salt is necessary.

Dr. Loew describes the preparation of the silver solution as follows:—(*a*) Prepare a 1 per cent. solution of nitrate of silver; (*b*) mix 13 cc. of a solution of potash (1·33 sp. gr.) with 10 cc. of caustic ammonia (1·96 sp. gr.), and dilute with water to 100 cc. Mix 1 cc. of each of (*a*) and (*b*) and dilute the 2 cc. to 1 litre immediately before use.

Occurrence of Aldehydes in Chlorophyllaceous Plants.*—J. Reinke and Krätschmar assert the presence of volatile reducing substances in all the chlorophyllaceous groups of plants; in algæ, lichens, mosses, ferns, conifers, and angiosperms; while they are absent from fungi and etiolated seedlings of flowering plants. Their occurrence appears therefore to be connected with the presence of chlorophyll, though they may spread to the parts which do not contain this substance. The authors determined the presence of two such substances of different reducing powers. From the powerful reducing properties, it is inferred that these substances belong to the class of aldehydes; and their power of reducing a neutral silver solution in the cold appears to identify them with formic aldehyde. If this should not be confirmed, they may possibly be identical with acetol or with some other "ceton-alcohol."

Organ not hitherto described in the Vegetable Embryo.†—G. Briosi describes a part of the embryo which he finds in some plants, and which has hitherto escaped attention. If the exalbuminous

* Berichte deutsch. chem Ges., xiv. (1881) p. 2144. See Bot. Ztg., xl. (1882) p. 57.

† G. Briosi, Sopra un organo finora non avvertito di alcuni embrioni vegetali. 15 pp. (3 pls.) Rome, 1882.

seed of *Eucalyptus globulus* is carefully examined, the embryo is seen to consist of two cotyledons and a radicle without plumule; but the radicle is found not to be of very simple structure. It is not perfectly cylindrical, but its lower extremity is somewhat club-shaped. A longitudinal section shows that its central portion is composed mainly of the tigellum or hypocotyl, surrounded near its lower extremity by a kind of collar through which the radicle projects. This collar is composed entirely of parenchymatous tissue containing no fibro-vascular bundle, and is completely covered with white hairs. As the seed germinates it developes to a considerable size, but finally disappears, leaving not a trace behind. The author believes that it is endowed with a nutritive function. He has observed it in the embryo of several genera of Myrtaceæ, also in Onagrarieæ and Lythrarieæ.

Studies of Protoplasm.*—In a series of papers under this title, J. Reinke proposes to classify the substances out of which protoplasm is composed under the three heads of "constant," "variable," and "accessory."

The author regards the first product of the assimilation of carbonic acid as probably formic aldehyde, according to the equation $CO_3H_2 - 2O = COH_2$. From this various polymeric substances are then produced, as, for example, grape-sugar, $6\ CH_2O = C_6H_{12}O_6$. The author distilled leaves of the poplar, willow, and vine with water, and reduced the distillate by Fehling's solution and solution of silver nitrate, by which the presence of an aldehyde-like substance was determined. The same result was obtained from roots of the willow, and with leaves which had remained for eight days in the dark.

Composition of the Protoplasm of Æthalium septicum.†—In continuation of previous investigations,‡ J. Reinke and H. Rodewald give fresh analyses of the protoplasm of *Æthalium septicum.* The plasmodium has, when fresh, an alkaline reaction. A turbid yellowish fluid, the enchylema, can be obtained by pressure; it contains albuminoids, and can be coagulated at a temperature of 58–64° C. The fresh plasmodium contains 71·6 per cent. of water; the following is an analysis of the ash:—

	Per cent.
Carbonic acid	36·02
Phosphoric acid	6·49
Sulphuric acid	0·42
Chlorine	0·21
Sesquioxide of iron	0·13
Lime	54·34
Oxide of magnesium	0·71
Potassa	1·41
Soda	0·18
	99·92

Extraction of the air-dried substance by ether yields from 5·36 to 8·13 per cent. of extract, which saponifies in alcoholic solution, and

* Unters. aus dem bot. Lab. Göttingen, 1881, pp. 74–184, 187–202.
† Ibid., pp. 1–75. See Bot. Centralbl., viii. (1881) p. 292.
‡ See this Journal, i. (1881) pp. 283, 918.

yields about 21 per cent. of paracholesterin. The volatile fatty acids found were propionic, butyric, caprionic, and probably caprinic acid, the non-volatile fatty acids, stearic, palmitic, and oleic acids.

The spores contain a larger quantity of asparagin than the protoplasm. The presence of acetic and oxalic acids was certainly, that of lactic acid probably, determined. In perfectly fresh protoplasm, Hoppe-Seyler's method determined the presence of myosin and vitellin; in the glycerin-extract was a ferment (pepsin) with the property of dissolving albumen.

Properties of the Protoplasm in Urtica urens.*—F. Kallen has investigated the phenomena displayed by the protoplasm of the stinging-nettle, in the merismatic cells, the medullary cells, the epidermal cells, the hairs, the glandular hairs, the stinging hairs, the cortical parenchymatous cells, the bast-fibres, the cells of the soft bast, the cambium cells, the wood-vessels, and the prosenchymatous cells. The following are the general results arrived at.

In all the cells the nucleus is densest and largest in comparison to the size of the cell in the youngest stage. In older stages of the parenchymatous cells there is frequent fragmentation; this occurs in the pith, the cortex, and the unthickened wood-parenchyma-cells. The finely punctated protoplasm exhibits at all stages a coarsely reticulate structure, as in the medullary cells; but the interstices are covered by a hyaline layer of protoplasm, so that the protoplasmic utricle is nowhere interrupted. The nucleus does not usually disappear before the protoplasm; in the sieve-tubes only does this take place; while in older stages of the bast-fibres, the nucleus is partially absorbed. In the xylem-vessels the nucleus and protoplasm never disappear. Crystalloids were in a few cases found in the nuclei of the hairs. The multinucleated bast-fibres contain latex. The nuclei of the bast-fibres multiply by fragmentation, not, as Treub supposes, by division.

Fertilization of Salvia splendens.†—W. Trelease describes the "ornithophilous" structure of this Brazilian species, the structure being especially adapted for fertilization by humming-birds. It is proterandrous, and there is no arrangement to facilitate fertilization by either day or night-flying insects.

Reproductive Organs of Loranthaceæ.‡—M. Treub has investigated the development and structure of the sexual organs in this natural order in the case of *Loranthus sphærocarpus*. The rudimentary carpels enclose a small cavity, in the middle of which rises a hemispherical central papilla, an elongation of the axis. This papilla is so connected with the carpels that only three or four canals remain open, and these also soon disappear. Before this complete union is effected, there can be detected in each free lobe of the central papilla hypodermal cells of larger size, which soon assume a nearly vertical

* Flora, lxv. (1882) pp. 65–80, 81–92, 97–105 (1 pl.).
† Amer. Natural., xv. (1881) pp. 265–9.
‡ Ann. Jard. bot. Buitenzorg (Java), ii. (1881) pp. 54–76 (8 pls.). See Bot. Ztg., xl. (1882) p. 59.

position, and divide, by transverse septa, into three superposed cells. Of the four or five rows of cells thus formed, the uppermost daughter-cell of one only developes, and becomes the embryo-sac; all the rest are resorbed, including the two belonging to the same row. Since each of the originally free lobes from the central papilla forms an embryo-sac, and the number of these lobes corresponds to that of the carpels, the number of embryo-sacs in the ovary also corresponds to that of the carpels. Round the embryo-sac is formed, partly out of the previous epidermal cells of the central papilla, a sheath of amylaceous cells, which is prolonged upwards into a similar row, while in the lower part of the ovary is developed a sheath of collenchymatous tissue open above. The embryo-sacs elongate to an extraordinary extent both upwards and downwards, following upwards the row of amylaceous cells till they reach the base of the style, and there somewhat expand; while they extend downwards to the base of the collenchymatous sheath. Their nucleus now divides; one of the daughter-nuclei moves into the upper expanded portion of the sac and again divides.

The first wall in the fertilized germinal cell is longitudinal, followed in each half by several transverse septa. The lower cells of this suspensor divide further, while the upper ones grow to an extraordinary length, and force the lower apex of the embryo between the first endosperm-cells, which have at the same time been formed in the lower part of the embryo-sac; the embryo being thus finally attached to the end of the double thread which constitutes the suspensor, and which is rolled up between the embryo and the endosperm. The endosperm cells now increase rapidly in number in its lower and peripheral parts, thus crushing the suspensor, which finally entirely disappears. The radicular end of the embryo then penetrates into the endosperm and consumes it; and the embryo becomes completely enclosed in the collenchymatous sheath; rising up into it, partly in consequence of the pressure of the lower part of the endosperm.

The central papilla formed in the centre of the ovarian cavity was regarded by Griffith as a placenta with rudimentary ovules; by Hofmeister as an orthotropous nucleus without integuments, in which several embryo-sacs are formed, and the chalaza of which is represented by the collenchymatous sheath. Treub supports the former view, and considers the axial portion of the papilla to be of the nature of a placenta, its three or four lobes being rudimentary ovules; a view confirmed by the somewhat similar structure presented by the Santalaceæ. Griffith thought that the single embryo was the result of the coalescence of several; Treub is unable to confirm this; but, on the other hand, found frequent evidence of the abortion of embryos, one only of which reaches maturity.

Structure and Mode of Formation of Spermatozoids.*—E. Zacharias has investigated the behaviour with different reagents of the various constituents of spermatozoids, chiefly those of *Nitella*

* Bot. Ztg., xxxix. (1881) pp. 827–38, 846–52.

syncarpa and *Chara aspera*. The spermatozoid he regards as composed of three parts—the spiral band, the paler terminal portion or vesicle, and the cilia.

A solution of pepsin does not dissolve the spiral band ; it becomes, on the contrary, more distinct and strongly refractive, either retaining altogether its original form, or becoming more or less short and thick; the separate coils sometimes coalesce into a single homogeneous refractive lump. The cilia are almost completely dissolved, while the posterior vesicle swells up, and finally again contracts. A dilute solution of sodium chloride causes the spiral band to swell up slowly, a peripheral denser part becoming differentiated from a central less dense part; the latter finally dissolves entirely, the former only being left in the form of a fine pellicle, which contracts and is coloured brown by a solution of iodine in potassium iodide. The posterior vesicle swells up, and then again contracts. The cilia do not contract, and are affected only by concentrated hydrochloric acid. The reactions with pepsin are also described in detail.

The spermatozoids of Muscineæ (*Fegatella* and *Lunularia*) agree in their behaviour, in all important points, with those of the Characeæ. Those of ferns and of *Marsilea* differ in some particulars. The spiral bands of the spermatozoids of an Australian *Marsilea* were distinguished by their extraordinary resistance to solvents, as was also the case with those of some ferns (*Hemitelia capensis*); while the cilia agreed in their properties with those of the Characeæ.

The author then compares the properties and reactions of the spermatozoids of cryptogams with those of the spermatozoids of animals, as investigated by Miescher, Schweiger-Seidel, Flemming, and others, and finds that in many respects the properties of the cilia and spiral bands of cryptogams agree respectively with those of the tail and head of animal spermatozoids. A similar relationship is found in the development of the different parts in spermatozoids belonging to the two kingdoms.

As regards the history of development of the spermatozoids of *Chara* and *Nitella*, the nuclei of the young mother-cells are composed of parts of various refrangibility, and each nucleus contains a nucleolus. The peripheral layer of the nucleus subsequently becomes denser, and the central part less dense. The nuclei at this time approach the outer wall of the cell, the rest of the protoplasm collecting at the opposite side. From the peripheral layer is formed the spiral band of the spermatozoid. The author was unable to decide whether the nucleolus takes any part in the formation of the spermatozoid, or whether the cilia are formed out of the nucleus, or, as Schmitz states, out of the cell-protoplasm.

The author considers that both the course of development and the chemical reactions indicate that in all probability the head of animal and the spiral band of vegetable spermatozoids owe the nuclei which they contain to the fact that they are formed from the nucleus of the mother-cell; while, on the other hand, the tail of animal and the cilia of vegetable spermatozoids are formed out of the cell-protoplasm.

Cell-nucleus in the Mother-cells of the Pollen of Liliaceæ.*—Investigations on this point have been carried out by A. Lalewski, mostly on *Lilium candidum* and *Allium Moly*. His mode of preparation was to place transverse sections of the young stamens in a 1 per cent. solution of acetic acid, slightly coloured by methyl-green. After a time, the nucleus acquires a beautiful blue colour, while the remaining contents of the cell continue nearly or quite colourless.

The large and fully developed cell-nucleus of *Lilium candidum* is enclosed, not in a pellicle of denser nuclear substance, but in an extremely delicate coat of cellulose. Immediately beneath the surface it usually contains a finely granular semi-transparent nucleolus, which is not coloured by methyl-green, and which remains unchanged up to a certain period in the division of the nucleus. After the initial stages, the membrane of the nucleus is resorbed, the vermiform structures which had been formed become straight, and place themselves in the equatorial region in the longitudinal axis of the cell, and, after completely coalescing at the poles, constitute the well-known "nuclear spindle." According to the author, the vermiform constituents of the nucleus are also enclosed in an exceedingly delicate coat or sac of cellulose, filled with dense protoplasm, which draws towards the equator, while the empty ends of the sacs become elongated, finally meeting and coalescing at the poles of the nucleus. Hence the number of nuclear or spindle-threads is normally the same as that of the elements of the nuclear plate. When the number of threads is larger than that of the elements of the nuclear plate, this is due to the protoplasm of some of the smaller elements of the plate being entirely used up in the formation of spindles. This stage is shortly followed by the splitting of the nuclear plate, which usually takes place by the protoplasm of the elements of the plate beginning to move in opposite directions towards the two poles, and thus assuming an elongated form. Reaching the wall of the cell, these strings of protoplasm coalesce in pairs into a V-shaped structure. The nucleoli, which have up to this point remained unchanged, now take part in the further changes in the cell. They move towards the middle of the cell, break up into smaller portions, and form in this manner both the protoplasm of the cell, which is compressed from all sides at the plate, and the material for forming the cell-plate. At the line of contact of the plate with the cell-wall of the mother-cell, the young cell-wall first appears in the form of a ring, which quickly grows inwards, and finally developes into a perfectly continuous division-wall. In the daughter-cells thus formed the nuclei divide in just the same way as in the mother-cell.

Crystalloids in the Cell-nuclei of Pinguicula and Utricularia.†—According to further observations of J. Klein, the crystalloids found in the cell-nucleus of these two plants strongly resemble not only one another, but also those found in *Lathræa squamaria*, a point of interest from the fact that Eichler advocates a closer genetic relation-

* Kosmos, 1881, pp. 158–74 (1 pl.). See Bot. Centralbl., viii (1881) p. 375.

† Pringsheim's Jahrb. für wiss. Bot., xiii. (1881) pp. 60–73 (1 pl.). Cf. this Journal, i. (1881) p. 477.

ship between this species and the two former than has generally been supposed. This resemblance relates not only to their form, but also to their chemical properties. They differ from ordinary proteinaceous crystalloids in being more soluble in water and in the cell-sap of dead cells. *Utricularia vulgaris* contains also crystals of calcium oxalate of regular octahedral form, but occasionally of a peculiar stellate or rod-like shape.

Cystoliths in Momordica.*—The occurrence of cystoliths has been at present determined only in the Urticaceæ and allied orders and in the Acanthaceæ and Cucurbitaceæ. Dr. O. Penzig now finds them in several species of *Momordica* (Cucurbitaceæ), especially *M. Charantia* and *echinata*. They occur almost exclusively in the leaves; in some instances also in the bracts. Their location is entirely in the lower layers of the epidermis (hypophyll); they are always attached to the radial lateral walls of the cell, presenting in this point a contrast to those of *Ficus*. They are never solitary, but always two or more in a corresponding number of adjoining cells.

In *Momordica echinata* the cystoliths are almost always in pairs, and they spring in adjoining cells from opposite points of the same wall. In the earliest stages of the leaf the cells of the hypophyll are all precisely alike. The mother-cells of the cystoliths then become distinguished by their larger size and more strongly refractive cell-contents. When they have attained about four times the size of the ordinary cells, they divide by an anticlinal division-wall, and the two cells thus formed may divide further or not. At a later period the mother-cells of the cystoliths are entirely destitute of chlorophyll and starch, containing only abundant protoplasm. A small protuberance of cellulose then appears on each side of the partition-wall, which developes into a cylindrical or club shape; and it is only when nearly fully developed that the deposition of calcium carbonate takes place in it. The mature cystolith always has, as in the Urticaceæ, somewhat the appearance of a bunch of grapes.

In *M. Charantia* usually three, four, or five contiguous cells produce cystoliths, one in each, and they then spring all from a common central angle; but eventually their base widens out, so as almost entirely to fill up the cells. The same process then infects a number of adjoining cells, so that eventually a large and complicated mass is formed, occupying a large number of the cells of the epidermis.

When the lime is removed by weak acetic acid, a slight skeleton remains, which is coloured dark yellow, passing into brown, by iodine solution or chlor-iodide of zinc. The cellulose reaction can, however, be obtained from it with care, and it probably consists of impure cellulose.

Sphero-crystals.†—J. Schaarschmidt has detected organic sphero-crystals in four natural orders of flowering plants in which they have not previously been observed, viz. Euphorbiaceæ (*Euphorbia*), Rutaceæ

* Bot. Centralbl., viii. (1881) pp. 393–400 (3 pls.).

† Magyar Novénytani Lapok, v. (1881) pp. 134–8. See Bot. Centralbl., ix. (1882) p. 46.

(*Haplophyllum*), Urticaceæ (*Urtica*), and Palmæ (*Nunnezharia* and *Phœnix*).

In *Euphorbia Tirucalli* they are unusually beautifully developed. In an early stage a centre of formation may be observed, which may be a chlorophyll- or starch-grain; round this is formed a massive nucleus, to which the crystals are attached with a radiate arrangement. Subsequently they exhibit evident stratification. The radiate portion is at first colourless, afterwards yellowish brown; the whole is evidently crystalline. The sphero-crystals are usually readily soluble in cold water; their behaviour towards reagents is similar to that of inulin.

In *Urtica major* the sphero-crystals are found in the guard-cells of the stomata and neighbouring cells, less often in the fundamental tissue. They are dark brown, insoluble in cold or in boiling water, and appear allied in their nature to hesperidin.

In *Nunnezharia* they occur in the peripheral fundamental tissue of the stem, forming large yellow clusters, also in the leaves, bracts, and rachis of the inflorescence. They are slowly soluble in cold water, and exhibit the closest resemblance to inulin.

Structure of Starch-grains.*—A. Meyer discusses Nägeli's theory of the formation of starch-grains by intussusception, and A. F. W. Schimper's † that they are sphero-crystalloids of a carbohydrate formed by apposition of concentric layers; and argues in favour of the latter, from the similarity of the phenomena they present to those of artificially prepared sphero-crystals of a carbohydrate such as sugar. In these the three following characters are found, which agree with those of starch-grains:—(1) Variations in the external conditions which affect crystallization cause also the formation of layers; (2) the centre of crystallization is less dense than the surrounding layers; (3) the youngest external layer is the densest, the density of the successive layers towards the interior decreasing with their age.

A full description follows of the starch and starch-generators in the rhizome of *Iris pallida* and *germanica*, the following being the general conclusions arrived at:—(1) The starch-generators in the rhizome of *Iris* only perish with the death of the cells in which they are found; (2) in them not only the formation but the solution of starch-grains takes place; (3) both internal and external solution of the starch-grains takes place in the cells; (4) the only simple explanation of all the phenomena observed is presented by the hypothesis that the starch-grains increase in substance by apposition.

Assimilating Tissue.‡—G. Haberlandt supports the view of Schwendener that the structure and arrangement of the cells which constitute the assimilating tissue are dependent on the process of assimilation. The more important cell-forms of which it is composed may be classified as follows:—

* Bot. Ztg., xxxix. (1881) pp. 841–6, 857–64 (1 pl.).
† See this Journal, i. (1881) pp. 481, 909.
‡ Pringsheim's Jahrb. für wiss. Bot., xiii. (1881) pp. 74–188 (6 pls.). Cf. this Journal, i. (1881) p. 912.

1. Elongated cells of tubular and cylindrical, rarely prismatic shape. Their position in relation to the surface of the assimilating organ varies. Most commonly they are vertical, in which case they are termed *palisade-cells*, less often parallel to the surface. When provided with arms or protuberances, they may be called *branched palisade-cells*; *funnel-cells*, when the end nearest the surface is of larger diameter than the other end.

2. *Tabular polyhedral cells*, with or without infoldings of the wall.

3. *Isodiametric cells*, with a tendency to rounding.

4. *Spongy parenchymatous-cells*, of stellate form and much branched.

The cell-walls are sometimes furnished with simple pits, and are usually thin and delicate. The chlorophyll-grains are as a rule from two to six times more numerous in the palisade-tissue than in the spongy parenchyma, from which the writer infers that the former is in an especial manner the assimilating tissue of plants. The assimilating cells frequently show infoldings of the cell-walls, as in *Pinus*, the object being to increase the surface of cell-wall, and thus provide room for a larger number of chlorophyll-grains. These folds are so arranged as to facilitate to the greatest possible extent the abduction of the products of assimilation.

Dependent on the characters already mentioned, the author classifies the various forms of assimilating tissue under ten types, arranged under the following heads:—(1) The assimilating tissue serves also as an abducting tissue. (2) Both these kinds of tissue are present, the products of assimilation passing out of the former into the latter. (3) Besides these two kinds there is also a special conducting tissue, through which the products pass in their way from the assimilating to the abducting tissue.

The spongy parenchyma subserves three distinct physiological functions:—(1) It is peculiarly the transpiring tissue of the leaf. (2) It is the conducting tissue. (3) In consequence of the larger or smaller quantity of chlorophyll which it contains, it is an assimilating tissue.

Light, which is the most important external factor in assimilation, while exercising a powerful influence on the arrangement of the assimilating system, scarcely affects its anatomical structure. It occasions the peripheral position of the special assimilating cells, and, in dorsiventral organs, their production on the illuminated side. The frequent occurrence of palisade-tissue is explained by the fact that the position of elongated cells at right angles to the surface of the organ favours the complete and intense illumination of the organ.

Every assimilating cell adjoins, at some part of its walls, the aerating system or intercellular spaces, which also serve to prevent the passing of the products of assimilation in unadvantageous directions.

The firmness of the assimilating tissue is secured by a variety of contrivances; as the thickening of the walls of the palisade-tissue in some species of *Cycas*, the columnar cells in *Hakea*, and the frequent occurrence of branched sclerenchymatous cells among the green cells.

There are often found cells and tissues which serve purposes of local assimilation, as glandular and stinging hairs, the guard-cells of stomata, &c.

The origin of the assimilating tissue varies greatly. It may arise from the cambium, the fundamental parenchyma, or the young epidermis.

The fundamental parenchyma of the stem passes without interruption into the parenchyma of the leaf-stalk, which is itself in connection with the parenchymatous sheaths of the vascular bundles of the leaf; this entire system forming the principal channel for the passage of the products of assimilation.

In addition to its primary function, the assimilating system of many evergreen leaves, as those of conifers, fulfils a secondary function, viz. the storing up of the products of assimilation during the period of repose.

Fibrovascular Bundles of Monocotyledons.*—The fibrovascular bundles of Monocotyledons are normally of two kinds, collateral, in which the xylem and phloëm run side by side, and concentric, in which a ring of xylem, usually closed on all sides, encloses a central mass of phloëm. L. Kny points out that not a few monocotyledons possess fibrovascular bundles which do not correspond to either of these types. Not unfrequently two or more groups of soft bast are separated by masses of sclerenchyma. In a number of palms bipartition of the phloëm occurs, and in *Rhapis flabelliformis* tripartition is the rule. Sclerenchyma frequently forces its way from both sides between the phloëm and xylem, separating them from one another. In *Testudinaria* and other Dioscoreaceæ the separation of the phloëm into two distinct groups is especially marked. The object both of this separation and of the interposition of sclerenchyma, the author believes to be the mechanical strength gained thereby.

Sieve-Tubes.†—E. Janczewski continues his researches ‡ on the sieve-tubes of Dicotyledons, with especial reference to *Aristolochia Sipho*, *Tilia parvifolia*, and *Vitis vinifera*.

They may be formed out of cambium-cells in two different ways:—(1) The cambium-cell, after detaching derivative cells on each side, developes the sieve-tube-cell directly; and the sieve-tubes are then arranged in radial rows, in contact with one another by their tangential walls; or (2) the cambium-cell divides longitudinally and tangentially into two cells of unequal size, of which the outer and larger one becomes the sieve-tube-cell either immediately or after the separation of lateral derivative cells, while the inner and smaller cell breaks up, by transverse division, into a row of parenchymatous cells. In this latter case they are separated from one another, and can touch one another only by their radial walls. A single cambium-cell

* Verhandl. bot. Ver. Prov. Brandenburg, xxii. (1881) pp. 94–109. See Bot. Centralbl., ix. (1882) p. 79.

† SB. Akad. Wiss. Krakau, ix. (1881) (5 pls.). See Bot. Centralbl., ix. (1882) p. 15.

‡ See this Journal, iii. (1880) p. 824.

will sometimes produce from two to four sieve-tube-cells by transverse division, and production of sieve-plates on the transverse walls.

The formation of sieve-plates commences with the development of symmetrical callus-warts on both sides of the terminal surfaces of the cell; the portions of cell-wall between these retain permanently their original chemical constitution, and form the future cellulose-sieve of the sieve-plate. A little later the callus-warts coalesce into a uniform mass covering the cellulose-sieve, in which perforations appear in place of the previous warts, causing a direct communication between the contents of adjoining sieve-tube-cells.

The period of existence of the sieve-tube may be divided, in relation to its physiological function, into three epochs. The first is the active period, characterized by the open sieve-plates covered with callus, the parietal layer of protoplasm in the tubes, and the formation within them of mucilage and sometimes also of starch-grains. In the second or transition period the tubes lose their contents, and the sieve-plate is covered by a homogeneous mass of callus, which soon begins to become absorbed. The third or passive period relates to those sieve-tubes the plates of which are again opened, but consist simply of a cellulose-sieve without any deposit of callus; the contents have either entirely disappeared, or are often reduced to a small quantity of mucilage, and the sieve-tubes can then at most only serve for the transport of watery fluids. The relative length of these different periods varies greatly in different plants.

The author finally examines the structure of the sieve-tubes of Monocotyledons, especially *Typha latifolia* and *Phragmites communis.* In the rhizomes of *Phragmites* the young sieve-tubes are developed out of the procambial cells, which first divide by tangential walls into two cells of unequal size; the outer and larger of these developes immediately into the sieve-tube-cell, while the inner and smaller one divides, by a number of transverse and radial divisions, into cambiform. The young sieve-tube is at first distinguished from the neighbouring procambial and young cambiform cells only by its larger dimensions, and by having lost its power of division. But soon the lateral walls thicken, and dots appear in them, and at the same time wart-like prominences on the terminal wall, which are at first small and are composed of pure cellulose, but gradually increase in size and assume a callose character. The subsequent processes resemble those in Dicotyledons.

A great difference is observable between the behaviour of the sieve-tubes in Monocotyledons and Dicotyledons. In the latter, after having once become passive, they are constantly replaced by the activity of the cambium, and therefore endure only for a few months, or at most a few years; in the former, in consequence of the absence of cambium, the activity of the tubes lasts much longer, in fact, as a rule, as long as the organ itself in which they are found.

The author concludes with the following general remarks. The elements of the sieve-tubes are always and everywhere prismatic, and are either horizontal or sharply truncate at the extremities. Their walls are always composed of pure cellulose, and are never strongly thickened. They are never entirely homogeneous, but are furnished with a larger or smaller number of dots, which in some cases always remain closed, as in Vascular Cryptogams, in others are at an early period covered with callose substance, being shortly afterwards changed into a true sieve by the appearance of numerous perforations, as in Phanerogams. The mature sieve-tube never contains a nucleus, having only a thin parietal layer of protoplasm which marks its vitality, and which entirely disappears with the death of the organ on the cessation of the life of the sieve-tube.

Structure and Functions of Stomata.*—A. Tschirch distinguishes the following distinct parts of the stomatal apparatus:—(1) The eisodial opening, or opening into the anterior chamber; (2) The opisthodial opening, or opening into the posterior chamber; (3) The central fissure; the true fissure between the two openings, which separates the guard-cells; (4) The outer and inner cuticular ridges, which are often circular and surround the two openings; (5) The outer stoma, or outer space which causes the depression in depressed stomata; (6) The circular wall, or margin which projects above the epidermis when the depression is pitcher-shaped; (7) The circular ridges when the stoma is funnel-shaped; and (8) The epidermal opening, or actual orifice of the outer stoma.

The author classifies the different forms of stomatal apparatus under eighteen types, which are described in detail.

Excessive evaporation is prevented, firstly by the form of the stomata themselves; and secondly, by various special contrivances for the purpose, as the structure of the epidermis and accumulation in it of incrustation of calcium oxalate; coatings of wax on the epidermis; hairy formations; limitation of the large intercellular spaces in the merenchyma of the leaf; the nature of the cell-sap; and the form and (frequently vertical) position of the leaves.

The number of stomata on a unit of surface in nearly related plants is larger in those which grow in moist, smaller in those which grow in dry habitats. The arrangement of the stomata is associated with purposes of protection. In those leaves which roll up when dry, the stomata on the concave side are enclosed; and the same is the case in grasses which grow in dry situations.

Stomata of Stapelia.†—J. Jákó describes the structure of the complicated stomata of *Stapelia variegata* and *trifida*, which presents considerable analogy to that in many Monocotyledons, especially *Tradescantia* and *Commelyna.*

Influences of External Forces on the Direction of Growth.‡—Sachs attributes the direction taken by pollen-tubes, after the grains attach themselves to the stigmatic papillæ, down the style, to the arrest of growth on the side in contact with the solid substance; Darwin, to the endeavour to avoid the light. L. Kny has attempted

* Linnæa, xliii. (1881) pp. 139–252 (1 pl.).

† Magyar Novényt. Lapok, v. (1881) pp. 151–6.

‡ SB. Bot. Vereins Prov. Brandenburg, xxiii. (1881). See Bot. Centralbl., ix. (1882) p. 10.

to determine this question experimentally, by immersing pollen-grains in a mixture of gelatine (first warmed) and a solution of sugar, with a very small quantity of extract of meat, in which nutrient fluid they readily put out their tubes. He finds that neither the spot to which the pollen-tube attaches itself, nor the direction which it afterwards takes, nor the rapidity of its growth, is in any way affected either by gravitation or by light, or by contact with a solid substance. Similar experiments on four fungi, *Mucor Mucedo*, *M. stolonifer*, *Trichothecium roseum*, and *Eurotium repens*, yielded similar results as far as gravitation was concerned, this force appearing to exercise no influence on the direction or rapidity of growth of the mycelial filaments, nor on their branching.

Water Distribution in Plants.*—G. Kraus having expressed and filtered the sap of *Lonicera tartarica* and *Datura*, and taken the specific gravity with the usual precautions, found it varied between 1·03 and 1·0059. The juice of sugar-beets ranged between 1·057 and 1·074. The specific gravity of the sap in the growing twig was found to be less in the older than in the younger portions, and growth was invariably accompanied by dilution of the sap, owing to constantly increasing absorption of water. The free acids and albumen also decreased in percentage, but increased in actual quantity. The increase in sugar during growth was remarkable; it increased with great rapidity up to a certain point, when it again declined, so that there is a maximum point in sugar contents, which is not at all coincident with the maximum of growth.

An extended series of observations shows that in crooked plants the under or convex side contains sap of less concentration, and poorer in free acid and sugar, not only relatively, but absolutely. Horizontal branches are richer in sugar than vertical. When plants are shaken so as to bend their tops towards the ground, an immediate increase of specific gravity in the sap, and an increase of sugar in the under or convex part of the bend takes place, showing that the sugar is in actual process of formation at the time of bending.

Causes of the Movement of Water in Plants.†—J. Boehm adduces experimental evidence in favour of his theory, already published, that the main factor in causing the motion of water in plants is not osmose, but the unequal pressure in different cells caused by the constant variation in the intensity of transpiration.

"**Compass-flowers.**" ‡—E. Stahl gives the results of his experiments with *Lactuca Scariola* and *Silphium laciniatum* for the purpose of ascertaining the conditions which cause their leaves to assume a meridional position. In the case of *Silphium*, the common "Compass-plant" of the Western States of America, the fact that the leaves point in a north and south direction has long been known, but in

* Bied. Centr., 1881, pp. 630–2. Journ. Chem. Soc., xlii. (Abstracts), 1882, p. 327. See also this Journal, iii. (1880) pp. 294–5.

† Bot. Ztg., xxxix. (1881) pp. 801–13, 817–27.

‡ Jen. Zeitschr. f. Naturw., xv. (1881) pp. 381–9 (1 (pl.). Cf. Amer. Journ. Sci., iii. (1882) pp. 159–60.

Lactuca Scariola, although it had been observed that the leaves were often vertical, Stahl was the first to notice that they generally stood in a meridional plane.

In both plants, the peculiar position of the leaves is best seen when they grow in unsheltered places, exposed to bright sunlight; while when crowded together, or growing in the shade, the leaves generally assume the common horizontal position. The leaves of *Lactuca* on the north side of the stem become vertical by a twisting of the petiole, the upper surface of the leaf facing the east. Those on the south side by a similar twisting become vertical with the upper surface facing the west. The leaves on the east and west side of the stem do not exhibit any torsion of the petioles, but they become upright with their upper surfaces approximated to the stem. Stahl took two plants growing in pots, and placed one where it would be exposed to direct sunlight from 10 o'clock until 3, and kept in the dark for the rest of the day; the other was placed so that from sunrise until 10 o'clock, and from 3 o'clock until sunset, it was exposed to the sunlight, but from 10 to 3 was in the dark. In the first case the leaves did not assume a meridional position, but in the second case they did.

That the meridional position is produced by the sun when near the horizon is clearly shown by the following experiment:—A pot with several young plants was placed in a window facing the north, where the plants received direct sunlight a few hours after sunrise and before sunset. In this experiment the leaves bent towards the north with their upper surfaces turning either to the east or to the west. The pot was then placed farther back in the room, so that the plants were not exposed to the direct sunlight, and the leaves then assumed a position at right angles to the diffused light from the window. Stahl concludes that the meridional position of the leaves of *Lactuca Scariola* is due to the common diaheliotropism observed in most leaves, and that these leaves differ from those of other plants only in their greater sensitiveness to intense light. In *Silphium* there is a torsion of the petioles as in *Lactuca;* and if the petioles are fastened so that they cannot bend, the blade of the leaf itself twists. Stahl states that a meridional position of the leaves can be seen clearly in *Aplopappus rubiginosus*, and to some extent also in *Lactuca saligna* and *Chondrella juncea*, and he believes that many other examples will be found, especially among the plants of dry and exposed regions.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Relation of Nutrition to the Distribution of the Sexual Organs on the Prothallium of Ferns.*—K. Prantl has made a series of experiments on the influence of different nutrient solutions on the development of the sexual organs on the prothallium of ferns, especially *Osmunda regalis* and *Ceratopteris thalictroides.* The following are the principal results at which he has arrived:—1. A deficiency of nitrogen

* Bot. Ztg., xxxix. (1881) pp. 753-8, 770-6.

is prejudicial to the formation of meristem; 2. Access of nitrogen will induce an amerismatic prothallium to pass over into a merismatic condition.

The development of the reproductive organs on the prothallium is closely connected with its nutrition. Amerismatic prothallia produce antheridia only, never archegonia; these latter organs being produced only in the neighbourhood of a meristem.

The author regards those prothallia of ferns which produce archegonia only and no antheridia as exhibiting the first step in the advance from the isosporous to the heterosporous Filicineæ.

Cell-division and Development of the Embryo of Isoëtes lacustris.* —Hofmeister formulated the general law that in cell-division each newly formed division-wall stands at right angles to the direction of the preceding most energetic growth. Sachs disputed this view; but Dr. F. Kienitz-Gerloff supports the previous view of Hofmeister, adducing as evidence the following instances:—The processes of division in filaments of *Cladophora*, especially in the formation of lateral branches; the division in the apex of a shoot of *Metzgeria*; the processes in the apical cell of a young rudiment of the sporogonium of *Archidium phascoides*, which divides by walls inclined in two opposite directions; the cone of growth of *Salvinia* exhibiting a similar structure; the breaking up of the apical cell of *Cladostephus*, on the cessation of growth at the apex at the commencement of the dormant season; the development within the apical cell in older prothallia of ferns and in embryos of mosses, which determines the direction of the division-walls; the formation of the cap-cells and of segments in roots with a three-sided pyramidal apical cell; as also in segment-cells generally.

The interior of the macrospore of *Isoëtes lacustris* is occupied by moderately large roundish cells, each having a nucleus; no diaphragm, like that of *Selaginella*, could be detected. Older unfertilized prothallia had from twenty to thirty archegonia. The first division-walls in the embryo divide it into octants. The cotyledon is formed out of the two anterior and upper octants; the first root out of the two posterior and upper ones; the foot out of the four lower octants. The further cell-divisions are followed out in detail.

The examination of the ripe and half-ripe spores is attended with great difficulty; the author has not found any hardening material adequate for obtaining good sections, and at the same time giving sufficient clearness to the preparation. Soaking for a time in glycerine answered for certain purposes.

Muscineæ.

Chemical Composition of Mosses.†—E. Treffner has investigated the chemical composition of several species of moss. He finds the amount of silica always high, and varying but little in different species; the greatest quantity was found in *Funaria*. *Orthotrichum*

* Bot. Ztg., xxxix (1881) pp. 761–70, 785–95 (1 pl.).

† E. Treffner, 'Beiträge zur Chemie der Laubmoose,' 62 pp., Dorpat, 1881. See Bot. Centralbl., ix. (1882) p. 9.

and *Dicranum* are distinguished by containing a large amount of oil. *Mnium* contains 10 per cent. of sugar; the proportion decreases successively in *Climacium*, *Polytrichum*, *Hypnum*, *Dicranum*, *Sphagnum*, *Orthotrichum*, *Schistidium*, and *Ceratodon*. Albumen occurs abundantly in the protoplasmic cells of the leaves; *Ceratodon purpureus* contains 12, *Polytrichum* 5 per cent.; but it is not in a condition serviceable for the nutrition of animals.

Fungi.

Influence of Oxygen on the Development of the Lower Fungi.* —F. Hoppe-Seyler states, as the result of a careful series of experiments, that an excess of oxygen greatly promotes the development of bacteria and micrococci, while it exerts a retarding influence on the production of yeast and true ferments, hindering fermentation by the transformation of the organic substances which ordinarily result from it, by active oxidation, into carbonic acid, water, and ammonia.

Chætomium.†—W. Zopf has followed out the life-history of this ascomycetous fungus, especially in the instance of *C. kunzeanum*. The ascospores germinate readily in saccharine vegetable juices, solution of sugar, decoction of dung, urine, and even in water. In addition to the mycelium formed in the substratum, there is generally an aerial mycelium, often of great luxuriance. The formation of perithecia begins after a few days, commencing in the centre of the mycelium, and advancing centrifugally. They proceed from both the submerged and the aërial mycelium, originating in the form of short erect branches, with dense and strongly refractive contents. The primary hyphæ now branch repeatedly, bending and interlacing, and thus producing a dense ball. No differentiation of ascogenous and enveloping hyphæ can be detected, as in other Ascomycetes. In the centre of this pseudo-parenchymatous mass of hyphæ is formed a hollow, into which the adjoining cells send down tubular septated projections, the "nucleophyses"; this results in the first and most important differentiation, into the peripheral part or perithecial wall and the central portion or nucleus. The nucleophyses, which correspond to the base of the perithecium, now undergo a more energetic development in comparison to the rest, being not only longer, but branching more copiously, forming a pseudo-parenchymatous cushion, on the outermost branches of which, projecting into the perithecium, are produced the asci, and, since all the terminal branches are fertile, there are no paraphyses. The hyphæ which clothe the lateral walls of the perithecium, branch but little, and remain sterile, may be termed "periphyses," those that constitute the ascogenous cushion "ascophyses." The wall of the perithecium becomes differentiated into an outer layer composed of narrow brown cells with slightly thickened walls, and an inner layer composed of thin-walled turgid cells. About the time when the asci are being developed, a mouth is formed

* F. Hoppe-Seyler, 'Ueber die Einwirkung des Sauerstoffs auf Gährungen,' 32 pp., Strassburg, 1881.

† Nova Acta Acad. Leop.-Carol., xlii. (1881) (7 pls.). See Bot. Centralbl., ix. (1882) p. 258.

at the apex of the cavity concealed by a dense funnel-shaped coating of hairs. The spores are produced eight in each ascus; the asci themselves and the periphyses deliquescing into a jelly, the swelling of which forces the numerous spores out through the opening.

If the nutriment is insufficient, small flask-shaped projections are formed on the mycelium, from the swollen ends of which are abstricted ellipsoidal or obovoid cells in basipetal succession; and these conidia may form balls which remain permanently attached to the apex of the sterigmata; but they, as well as those which may be produced on other parts of the mycelium, appear to have lost their power of germination.

Similar results were obtained from other species; but *C. fimeti* has no opening to the perithecium, and *C. bostrychodes* forms no conidia.

With regard to the systematic position of *Chætomium*, it differs from other genera of Ascomycetes, as *Eurotium*, *Erysiphe*, *Penicillium*, *Sordaria*, and *Ascobolus*, in the absence of any distinct differentiation of the rudimentary fructification into ascogenous and enveloping hyphæ, agreeing on this point with *Peziza Fuckeliana* and *Pleospora herbarum*. *Peziza* is, however, a gymnocarpus Discomycete; and from *Pleospora*, *Chætomium* differs in the perithecium originating not as a tissue but as a mass of hyphæ, and in the process of differentiation of the fructification. *Chætomium* must therefore be regarded, like *Pleospora*, as a special type of Pyrenomycetes. Since the Perisporiaceæ have perithecia closed on all sides and without any opening, while *Chætomium* resembles the Sphæriaceæ in having such an opening, it is evident that the boundary line between the Perisporiaceæ and the Sphæriaceæ is not so sharp as has generally been supposed.

Zopf divides the genus into two subgenera:—(1) Euchætomium;—perithecium with terminal tuft of hairs and an opening (*C. spirale*, *murorum*, *pannosum*, *crispatum*, *bostrychodes*, *kunzeanum*, *cuniculorum*, *indicum*, and *elatum*); and (2) Chætomidium:—perithecium without any opening or terminal tuft of hairs; furnished at its base with thick wiry rhizoids (*C. fimeti*). Several of these species are new.

Completoria complens, a Parasite on the Prothallium of Ferns.*—This fungus has been found by Leitgeb on the prothallium of *Pteris cretica* and other ferns, and even, in some cases, on the leaves. It penetrates the host from without in the form of a spherical cell, which attaches itself by a stalk-like prolongation to the outer wall of the cell of the host, occupying about the centre of the cell-cavity. The contents consist of finely granular protoplasm, the wall is extremely delicate, and the pedicel is usually enclosed for half its length in a dark-brown sheath. It then puts out a number of prolongations which penetrate the adjacent cells. The reproductive cells are of two kinds, conidia and resting cells; the formation of zoospores seems probable, but has not yet been observed; the resting spores, which vary in diameter between 18 and 25 μ, are formed especially when the supply of nutriment is insufficient.

* SB. k. Akad. Wiss. Wien, lxxxiv. (1881) (1 pl.). See Bot. Centralbl., viii. (1881) p. 226.

As regards the systematic position of the fungus, Leitgeb considers that it may bear a similar relation to the Peronosporeæ to that of the Chytridiaceæ to the Saprolegnieæ; in both we have degraded forms in which the production of sexual organs has been lost, the resting spores taking their place.

Rehm's Ascomycetes.—This most valuable and important collection of dried ascomycetous fungi has now reached twelve parts, and includes no fewer than 600 species, 281 belonging to the Discomycetes, and 319 to the Pyrenomycetes. Of these 59 of the former and 37 of the latter are new. The most recently published part contains detailed and exact descriptions of all these new species, as well as critical remarks on all the other species already included in the collection.

Destruction of Insects by Yeast.—In 1880 we called attention* to some experiments of Professor H. A. Hagen, of Cambridge, Mass., the results of which showed (he considered) that the yeast fungus entered the body of the insect on which it was sprinkled, and produced a growth fatal to the life of the insect. Professor Lankester, however, at the time pointed out that the more probable explanation was that the yeast fungus itself was innocuous, but that it was a vehicle for such a parasite as "green muscardine" (*Isaria destructor*), which Metschnikoff found was best cultivated by the use of beer-mash.

Mr. T. H. Hart, of Ashford, having tried the application of yeast, reports † to Professor Hagen that while a first experiment was successful all subsequent ones failed, and he feared therefore that yeast is too uncertain in its application to be of practical use. To this Professor Hagen replies as follows:—

"It seems evident that the yeast has not contained *Isaria* or other fungi obnoxious to insects to which the first success could be ascribed; otherwise the later application of the same fluid ought to have had the same effect, or even by the multiplication of the fungi a more marked effect.

"Experiments made in Germany and here (U.S.A.) had exactly the same result—first success, later failure. . . . After all, I believe it can be concluded that *a certain stage* of the yeast solution is needed to make it effective, and that after this stage it becomes indifferent. That yeast solution has killed insects seems to be undoubtedly proved, and it remains only to find out the stage in which its application is successful. It is sure that success, even in a very small number of experiments, cannot be annihilated by failure in other experiments."

Development of Fungi on the Outside and Inside of Hens' Eggs.‡—C. Dareste put an egg (for artificial incubation) in a vessel hermetically closed by an indiarubber stopper, and of small capacity (about 0·35 litre). On the sixth day the egg was covered with green spots of fructified mould; then there appeared on the

* See this Journal, iii. (1880) pp. 246–8.
† Canadian Entomologist, xiv. (1882) pp. 38–9.
‡ Comptes Rendus, xciv. (1882), pp. 46–9.

shell white filaments of mycelium, which in their turn soon showed fructification. When the egg was opened, some days afterwards, a tolerably thick layer of mycelium was found adhering to the shell-membrane. There was no trace of an embryo. Experiments with sixty eggs having the same origin gave only three entirely free from the cryptogamic vegetation. In several the embryo had begun to develope, and had been destroyed in the course of the first week. There were also in all the eggs considerable masses of mycelium, usually occupying certain points on the internal surface of the shell membrane, but, in certain cases also, floating in the albumen or ramifying in the yolk. When this mycelium was produced in the region of the air-chamber, the cavity was filled with fructifying green mould. The moulds were of several species (often co-existent), the most frequent being *Aspergillus*.

The author then considers the origin of these growths, and whether they ought to be attributed to the germination of spores adhering to the walls of the vessels used in incubation, or contained in the air inside them; to spores deposited on the shell during the interval between laying and incubation; or to spores enclosed in the egg itself before the completion of its formation in the oviduct?

Numerous experiments have led M. Dareste to doubt the two former explanations, he having heated the vessels which were to contain the eggs to 120° C. in order to kill any spores, and at other times used the spray of carbolated water; the vegetation nevertheless developed as abundantly as before. He therefore supposes that the spores were enclosed in the egg at the time when the yoke becomes covered in the oviduct with layers of albumen.

As, however, the methods used to destroy the spores are open to objection, he would not consider the latter to be the most probable hypothesis, did not other experiments point to it. The eggs used in the first experiments all came from the same locality (Seine-et-Oise). A batch of eggs from the department of Vienne, however, only had three infected eggs, and eight which were exempt. Eggs from the departments of the Oise and the Eure were experimented on at the same time as those from the Seine-et-Oise, and the latter, at the expiration of twelve days, had five eggs infected out of six. On the other hand, six eggs from the Eure had only two infected. The seven eggs from the Oise were, on the contrary, perfectly intact. This difference between eggs placed in absolutely identical conditions can only be explained by the inclosure of the spores in the eggs, in the oviduct, and before the formation of the shell. It shows also that the cause which infects the eggs is essentially local.

Gayon has demonstrated the mechanism of this infection. He has shown that the prolapsus of the oviduct, at the moment of copulation, places its mucous membrane in contact with that of the cloaca, and also with that of the cloaca of the cock. The oviduct, in resuming its original position, draws in with it the microbia and all the foreign bodies which it may find in these cavities. These circumstances are similarly produced at the moment of laying. The existence of foreign bodies in the interior of eggs has also often been proved. M. Dareste recently observed that there were in the albumen of an egg some pellicles of bran perfectly recognizable by their structure, and by the considerable number of starch-grains which they contained; these pellicles were quite 1 mm. in diameter. The diameter of the spores can only be reckoned by thousandths of a millimetre.

In the experiments above described the eggs were in an atmosphere completely saturated with humidity in consequence of the insensible transpiration of the egg, but even in the ordinary conditions of incubation the spores enclosed within it may germinate, and the greater or less abundance of the vegetation may completely prevent the development of the embryo or arrest it after it has begun. This is one of the principal causes of the premature death of the embryo, and also of the inequalities constantly observed in the results of incubation.

Biology of Bacteria.*—During his researches on bacteria as reagents for the physiological disengagement of oxygen,† T. W. Engelmann had occasion to examine whether light could exercise a direct action on the movements of the bacteria. Nothing had at that time suggested such an influence. Experiments had been made on the ordinary bacteria of putrefaction (*B. termo*). The temperature, the tension of the oxygen, the proportion of carbonic acid, the concentration of the medium, the intensity, the colour and duration of action of the light had been modified in very different ways.

Later on, whilst repeating these same experiments on Vibrios and *Spirilla*, the author also obtained negative results, with one single exception.

A drop of water, which, besides a quantity of *Spirillum tenue*, only contained a few specimens of *Micrococcus* and a *Bacterium* of larger size (2–3 μ) being illuminated over a very small portion of its surface, there collected in less than half a minute,‡ at the illuminated spot, hundreds of *Spirilla* and, besides, some of the little cocci and larger bacteria. In the dark, and even in green or blue light, they re-distributed themselves, but not in the red light, even where it was of relatively feeble intensity. It may be presumed from this fact that there was a disengagement of oxygen, for when the gas failed them, the organisms in question accumulated round every source of oxygen (air-bubble, edge of the glass, cover-glass, and green cells) which was accessible to them.

The accumulation of *Spirilla* and bacteria at the illuminated spot did not take place when the drop of water was uncovered and in continuous contact with the atmospheric air or with a mixture of hydrogen and oxygen. They accumulated, however, as soon as a current of pure hydrogen was passed through the gas-chamber, to disappear again almost immediately as soon as a little oxygen was allowed to enter.

* Rev. Internat. Sci., ix. (1882) pp. 276–8. See also Bot. Ztg., xl. (1882) pp. 321–5, 337–41. † See this Journal, i. (1881) p. 962.

‡ At least when the preparation had remained for some minutes covered with a thin glass.

As the *Spirilla* greatly predominated, as much in number as in volume, the author had at first considered it probable that it was they which disengaged oxygen under the influence of light. But *Spirilla*, even in thick layers, are quite colourless. We should, therefore, have here the unheard-of fact of a disengagement of oxygen without the agency of chlorophyll or of some pigmentary matter of equivalent function. This would demand extreme scepticism.

Later researches have shown that the *Spirilla* only approach the light when the drop also contains the larger bacteria mentioned above. The latter appeared constantly, although in very small numbers, at the illuminated spot, before the accumulation of the *Spirilla* began. On examining these bacteria with a high power and a good light, it was seen that they were of a greenish colour, but less intense, however, than that of most chlorophyll-grains of the same size. The author gives them the name of *Bacterium chlorinum.* They are not identical with *B. viride* and *Bacillus virens* of Van Tieghem, which are motionless forms. *Bacterium chlorinum* has, in a high degree, the tendency of accumulating in the light, but only when oxygen is absent. It is a property it shares with some other green micro-organisms, for instance, with *Paramecium bursaria.*

These results make it very probable that the accumulation of *Spirilla*, cocci, and bacteria, in the light, described at first, was the consequence of the disengagement of oxygen produced by the *Bacterium chlorinum* assembled in the illuminated spot. This explanation, however, only seems acceptable on the supposition that the *Spirilla* only required very little oxygen, much less than the ordinary bacteria of putrefaction, although they are much smaller.

To verify this supposition, the author has examined the behaviour of *Spirilla* under different tensions of oxygen. He found that in hydrogen gas as free as possible from oxygen, and even under a plate of glass with hermetically closed edges, they move rapidly many hours after the motion of the bacteria of putrefaction has ceased. Covered with a piece of glass, the *Spirilla* do not accumulate, like *Bacterium termo*, at the very edges of the cover, but at some distance under the glass. If the tension of the oxygen diminishes in the gas-chamber this distance decreases; if the tension increases the *Spirilla* retire further. Similar phenomena are observable under the glass cover, around air-bubbles, and green vegetable cells, living and exposed to the light. When the latter are strongly illuminated the zone of *Spirilla* ceases at a certain distance from them, parallel to their surface; it approaches when the luminous intensity diminishes, and *vice versâ.*

There is therefore no doubt that the tension of oxygen most favourable for *Spirilla* is not much lower than for *Bacterium termo.* It is certainly less than 150 mm. Hg., and may be considerably less. The *Spirilla* re-act at relatively very slight variations of the tension of oxygen. In these respects they behave like certain Flagellata (i. e. *Monas termo*) and Ciliata (*Glaucoma scintillans*), which develope by preference in putrefying liquids.

Vibrios—which, according to the author, cannot be strictly separated morphologically from *Spirillum*, *Bacillus*, and *Bacterium*—also behave, as regards the tension of oxygen, almost exactly like *Spirillum* and not like *Bacterium termo*.

The author regards* *Spirillum* as remarkably sensitive to the presence of free oxygen; and he considers that the vital phenomena of both the lowest vegetable (Schizomycetes) and the lowest animal forms (Infusoria) are closely parallel to those of higher animals; their activity being dependent, in almost the same degree, on their requirements of oxygen and of solid and liquid food for carrying on their vital processes.

Influence of Concussion on the Developments of the Schizomycetes.†—J. Reinke has determined, by a careful series of experiments, that mechanical concussion produces a hindering effect on the production of Schizomycetes. He believes the cause to be the same as that of the retarding influence of light, viz. the concussion occasioned between the minute particles of protoplasm.

Experimental Production of the Bacteria of the Cattle-distemper.‡—C. v. Nägeli has carried out a series of experiments on the conditions under which the bacteria are produced which accompany the distemper of cattle. The most important fact established is that these bacteria are capable of transformation into a transitional form which may constitute a pellicle on the surface of the nutrient fluid, possessed of spontaneous motile properties, and which has a very slightly infectious character; constituting a transitional stage towards the hay-bacteria. The following is a tabular arrangement of the characters of the three primary forms, when grown in three different substrata. The author is strongly of opinion that these three fungi are simple adaptive forms of one and the same organism, *Bacterium subtile*.

	Distemper-bacteria.	Transitional Form.	Hay-bacteria.
1 p. cent. extract of meat.	Solution clear; cloudy at the bottom.	Solution cloudy, a loose mucilaginous pellicle; flakes and pieces of the pellicle at the bottom.	Solution clear, with a solid dry white pellicle, submersed with difficulty.
Slightly acid infusion of hay.	No increase.	Formation of a slight white rim on the surface of the fluid.	A dry pellicle moistened with difficulty, usually appearing wrinkled or pulverulent.
A living animal.	Infectious in very small quantities; distemper.	Infectious only when increased more than a thousand-fold; distemper.	Not infectious in the largest quantities.

* Pflüger's Arch. f. d. gesammte Phys., xxvi. (1881) pp. 537–45.
† Ibid., xxxiii. (1881) pp. 443–68. See Bot. Centralbl., viii. (1881) p. 307.
‡ SB. Akad. Wiss. München, 1882, pp. 147–69.

Bacteria of Caucasian Milk Ferment.*—E. Kern describes a new genus and species of bacteria found in "kephir," a drink prepared by the inhabitants of the high-lying lands in the Caucasus by fermentation of cows' milk. It is also used as a remedy against different diseases.

As a ferment in its preparation strange white lumps are employed, of a spherical or elliptical shape, in size from 1 m. to 5 cm. Microscopical examination showed that they consisted of yeast-cells and bacteria. The yeast-cells are the ordinary form, produced by cultivation, of *Saccharomyces cerevisiœ*, but Kern was unable to get these to the spore-bearing stage. The bactèria composed the chief part of the lumps, and were in the zooglœa state. The vegetative bacteria cells were 3·2 m. to 8 m. in length and 0·8 broad. In preparations put up by drying, a distinct cell-membrane could be distinguished.

Treated after Koch's method, the cells show at one end a locomotive organ, which resembles a cat-o'-nine-tails of threads. When exposed to acids or a high temperature, the cells grow out, probably through progressive cell-divisions, into long *Leptothrix* threads, which change generally precedes the spore-formation stage. The spores are round, always formed in twos in each cell, and are always placed standing on their ends; even by a Hartnack immersion X, no partition-wall could be discovered between the spores. In the *Leptothrix*-threads rows of spores could be observed, which are, however, always so situated that two spores belong to each cell. The spores while still in the cells are 0·8 μ in size; those lying free attain the size of 1 μ; the germinating spores swell up 1–6 μ. The germination of the spores generally takes place in such a manner, that an exosporium and an endosporium can always be distinguished in them. The thinner endosporium arises out of the thicker exosporium, first as a small excrescence, which gradually increases, developing more and more into a long cylindrical tube, and then begins by cell-division to form vegetative cells. The whole course of the development to the spore formation, beginning with the vegetative cell to the formation of a similar new cell, was followed.

This new form of bacteria, which undoubtedly belongs to the Desmobacteria of Cohn, is, in its vegetative state, not unlike *Bacillus subtilis*; it is, however, clearly distinguished not only from it, but also from all other kinds of Bacteria by its spore formation, since it always forms in each cell two round spores, placed end to end, while in the species of Bacteria hitherto described, only one spore has been noticed in each cell. On account of this sharply marked feature Kern places this form of Bacteria in a new genus, next to *Bacillus*, and calls it *Dispora caucasia* nov. gen. et sp.

A more exhaustive essay on the subject, with explanatory plates, Kern promises in a forthcoming number of the 'Bulletin de la Société Impériale des Naturalistes de Moscou.'

* Bot. Ztg., xl. (1882) pp. 264–6. Cf. Nature, xxvi. (1882) p. 43.

Parasitic Organisms of Dressings.*—The dressings of wounds sometimes acquire a blue or green colour. C. Gessard finds this to be due to a small mobile parasitic organism which he was able to cultivate in sterilized urine or a decoction of carrots. It is developed in saliva, sweat, albuminous liquids, &c. The blue pigment it secretes is the pyocyanine of Fordos. A current of sulphuretted hydrogen turns it green and then yellow, and the organism has the same action by reason of its avidity for oxygen.

Parasitic Nature of Cholera†.—Max v. Pettenkofer argues in favour of the origin of cholera from parasitic organisms. These organisms he believes to be propagated by intercourse with places in which the disease is epidemic or endemic; but that, when removed to another place, without losing their poisonous properties, they propagate themselves only when they find at this place a substratum which serves as their nutrient or as host, and which comes into contact with man either directly or in the soil of their dwellings. Even where cholera breaks out apparently without any connection with the soil, as in ships, he believes the germ comes into contact with the substratum brought from the land. The only effectual remedy for cholera he believes to be the purifying of the soil by drainage, &c., the ventilation of dwellings, cutting off of infected water, and similar means.

Parasitism of Tuberculosis.‡—H. Toussaint collected in a carefully cleansed vessel the blood from a cow affected with tuberculosis, allowed it to coagulate, and transferred the serum which separated after coagulation into some Pasteur's tubes filled with infusion of the flesh of cats, swine, and rabbits, and placed them in a warm chamber. After a few days there were formed in these fluids very small simple granules, united into pairs or in masses. From these was made a second culture with which kittens were infected, but they died before tuberculosis manifested itself. Five months afterwards he inoculated two older cats from the remaining serum, which still showed the globular granules. These died 47 days after inoculation; one exhibited a moderately conspicuous local lesion, and a considerably swollen axillary gland, but no tubercles in the lungs; the other, similar lesions, as well as of the lymphatic glands, and a number of minute tubercles scattered through both sides of the lungs. A second culture from the blood of a cow affected with tuberculosis must be regarded as having failed, since the greatest variety of microbia made their appearance. On the 1st of March he killed a pig which had been fed with the lungs of a tuberculose cow, containing a great number of tubercles, and in which all the lymphatic glands were cheesy. Blood and the pulp from the lymphatic glands were mixed with a slightly alkaline infusion of

* Comptes Rendus, xciv. (1882) pp. 536–8.

† Zur Aetiologie der Infectionskrankheiten, 1881, pp. 333–52. See Bot. Centralbl., ix. (1882) p. 25.

‡ Comptes Rendus, xciii. (1881) pp. 350–3.

the flesh of rabbits, which they soon rendered turbid, all developing the same microbium. The cultures, which were continued up to the tenth, completely retained their purity. After ten or twelve days they always ceased to increase, the exhausted fluid became clear, and the microbia fell to the bottom, forming a yellowish sediment. This sediment consisted entirely of extremely minute granules, which were produced singly or in pairs, groups of from three to ten, or in small irregular masses. During the early days of the culture white spots appeared, resembling the filaments of bacteria, which could be sucked up through a fine tube. They remained for some days in the clear fluid without becoming absorbed, the microbium being at this time enclosed in a somewhat firm mass of mucilage.

Experimental Tuberculosis.*—D. Brunet records experiments on inoculation with tuberculosis made in 1869 on rabbits. Nineteen young rabbits were infected, seven with serum from a cancer, six with serum from an ordinary ulcer, and six with tuberculose matter. Of the nineteen, fourteen became tuberculose, the remaining five escaped. Since infection with cancer-serum produced tuberculosis as often as infection with tuberculose matter, he thought it probable that the infecting mass itself produced no specific action, but that it behaved as a foreign body, causing inflammation around it, and that this gave rise to tuberculosis. Since the matter from ordinary ulcers was more easily absorbed than solid matter, it produced a smaller degree of inflammation, and hence gave rise less often to tuberculosis.

Etiology of Tubercular Disease.†—The circumstantial evidence that tuberculosis is a chronic infectious disease has been of late years repeatedly insisted on by Cohnheim and others, and the hypothesis that it is due to a specific organism has received considerable support from the discovery of parasitic elements as the *materies morbi* of some other chronic infectious diseases, such as leprosy. But the organism of tubercle has hitherto eluded research. Its discovery is at last announced by the distinguished worker to whose investigations much of the progress of bacterial pathology has been due, Dr. R. Koch.

It is only by means of a special method of preparation and examination that the bacteria can be detected. The method consists essentially in a process of colouring the organisms, and their examination under very strong illumination; but the details of the method have to be varied according to the tissue examined, whether a secretion, blood-tissue fluid, or a section of an organ or tissue. If, for instance, it is desired to demonstrate the presence of the tubercle-bacilli in the fluid of the tissues, a thin layer of this is spread over a cover-glass, it is then dried and warmed for a few moments over a flame, so as to

* Comptes Rendus, xciii. (1881) pp. 447–8.

† Verh. Physiol. Gesell. Berlin, 1882, p. 65. Lancet, 1882, pp. 655–6. Naturforscher, xv. (1882) pp. 149–50.

render it insoluble; it is then placed for twenty-four hours in a mixture of 1 cubic centimetre of a concentrated solution of methylene-blue in alcohol, 0·2 cubic centimetres of a 10 per cent. solution of potash, and 200 cubic centimetres of distilled water. The preparation is by this coloured blue, and on it is then placed a few drops of a solution of vesuvin. This has the effect of discharging the methylene-blue from all the tissue elements, but not from the bacilli. The former are of a brown colour, and the blue bacilli are conspicuously defined. The preparation is then treated with absolute alcohol, oil of cloves, and Canada balsam, in the ordinary manner. This peculiarity of being rendered visible by the combined action of methylene blue and vesuvin is possessed only by the tubercle bacilli and by those of leprosy. All other bacteria and micrococci, known to Koch, lose, under the action of vesuvin, the blue colour which they acquire from methylene-blue. This constitutes a striking instance of the pregnant value of the colouring methods in thus, by quasi-chemical action, bringing out differences between minute organisms which are apparently so similar, and justifies the expectation that, by analogous means, differences may be demonstrated between the organisms of acute diseases which are now separable with so much difficulty and uncertainty, and may be the inauguration of a new era, not only in the etiological knowledge of acute diseases, but also in the organization of measures for their prevention.

The bacilli of tubercle, when rendered visible by this method of double coloration, are seen as very small rods, in length about one-third the diameter of a red blood-corpuscle, and in breadth about one-sixth of their length. In some of them distinct spores may be seen, as minute, unstained, refracting, vacuole-like structures, distinguishable, however, from the vacuoles in that at their position there is a slight fusiform enlargement of the bacillus. They are most abundant in recent tubercular neoplasms, and least numerous in the caseating centre of old miliary tubercles. They are also visible within the giant cells, usually isolated, but sometimes forming well-marked sheaf-like bundles. Koch found the same organisms in the walls of tuberculous cavities, in the sputum of phthisical patients, in degenerated scrofulous glands, in fungous joints, and in the bones of tuberculous cattle. They were never absent from the tubercular new formations produced by inoculation, even in animals of the most different species.

In order to ascertain the all-important question whether these organisms are actually the *materies morbi* of tuberculosis, Koch has carried on an extensive series of culture-experiments, which have yielded the most striking results. As a culture-liquid he employed sterilized blood-serum from the ox. The sterilization was effected in the method recommended by Tyndall, by placing the serum in a test-tube closed with a plug of wadding, and exposing it for an hour on each of several successive days to a temperature of 58° C. After this had been repeated for about six days, the temperature was raised to 65° C., and the previously fluid serum became transformed into a yellowish, translucent, but slightly opalescent mass of the consistence of coagulated gelatine. Its translucency permitted the growth of organisms, either on its surface or in its depth, to be readily recognized by the resulting opacity. In order to increase the area of the free surface of this culture soil, it is recommended to incline the test-tube at the moment of coagulation. A small fragment of excised tissue was introduced into a tube under special precautions, to avoid contamination with ordinary bacteria of putrefaction. Fresh miliary tubercle answers best, taken from an animal affected with inoculation-tubercle, and killed shortly before. If the glass is kept at a temperature of 37° or 38° C., at the end of about ten days the first effect of culture is observable as fine white points and streaks on the surface of the serum. Fresh glasses may be inoculated from this first culture, and so a series of generations may be obtained. Some of these series of cultures were continued for two hundred days. Under the microscope these greyish-white masses on the surface of the serum are found to consist of precisely the same bacilli as can be demonstrated by means of the method of double coloration, in the primary tuberculous tissue. If a small portion is inserted into the anterior chamber of the eye of an animal, injected into its blood, or inoculated beneath its skin, there results a wide-spread tuberculosis of almost all the organs and tissues, which has a more rapid course than when the inoculation is made with ordinary tuberculous material. The first symptoms are to be observed in guinea-pigs ten days after the inoculation. Even animals which enjoy an almost complete immunity from tuberculosis, such as dogs and rats, are affected rapidly, and with certainty. In some of the animals which died after these inoculations, the amount of tubercle developed in the tissues was enormous, being hardly ever equalled in the human subject.

Koch determines the limits of temperature between which the tubercle-bacillus can develope and multiply. The *minimum* temperature he finds to be 30° C., and the *maximum* 41° C. He concludes that, unlike the *Bacillus anthracis* of splenic fever, which can flourish freely outside the animal body, in the temperate zone animal warmth is necessary for its propagation. He also points to the grave danger of inhaling air in which particles of the dried sputa of consumptive patients mingles with dust of other kinds.

These experiments seem to demonstrate that the organism which is revealed by the method of double coloration is really the pathogenic element of tuberculosis. The researches appear to have been conducted with admirable care. The experiment will no doubt be soon repeated. Indeed, in the brief interval which has elapsed since the demonstration by Koch, on March 24th, his observations have received independent confirmation by Baumgarten, who has published in the Centralblatt für Med. Wiss. an account of his observations. In every new formation of artificially produced tuberculosis in the guinea-pig he found innumerable quantities of the rod-shaped bacteria infiltrating the area in diminishing intensity from the centre to the circumference. As far as the tubercular growth can be traced the bacterial infiltration extends. His description of the organisms agrees closely with that of Koch, but he observed that the extremities of the rods frequently presented a knob-shaped or wedge-shaped enlargement. They were very rarely united in pairs, and never massed in the so-called zooglœa form. He corroborates their characteristic of resistance to the ordinary methods of tinting, and only succeeded in bringing them into distinct view by dilute alkalies. In a postscript Baumgarten adds that he has succeeded in finding the same organisms in human tubercle. The pathological importance of the discovery of the proximate cause of this frightful scourge of the human race cannot be over-estimated, nor is it possible to foretell the practical results to which it may lead.

Lichenes.

Structure and Development of the Apothecia of Lichens.*— The well-known structure of the apothecium of lichens described by Stahl is taken from the Collemaceæ, where it is a product of an act of impregnation performed by the spermatia. The female organ or carpogonium here consists of two parts, a lower coiled portion, the ascogonium, and an upper multicellular filament, the trichogyne, through which impregnation by the spermatia takes place. After this process the trichogyne dies, and a fibrous tissue springs from the ascogonium, composed of the asco-filaments which later develope into the asci; these are therefore the product of the fertilized ascogonium, with which the paraphyses have no direct connection.

Since the Ascomycetes vary greatly in the mode of development of their fructification, it is to be expected that a similar variation should exist in the development of the ascogonium of lichens, especially in those genera which do not possess a spermogonium. G. Krabbe has investigated this subject in detail, with special reference to the genus *Sphyridium;* and the following are the main results at which he has arrived. The author throughout uses as synonymous the terms apothecium, fruit, fructification, and reproductive shoot.

1. The genus *Sphyridium* exhibits a differentiation between the apothecium resulting from an entire scale of the thallus or from a part of one. The asco-filaments are the apices of ordinary hyphæ, the cycle of development of *S. carneum* terminating with their production. The production of the ascogonium is most probably independent of any act of impregnation.

2. In *Cladonia* two morphologically different structures exercise the function of fructification in different species, viz. *a*, a pseudopodetium or modification of the thallus; *b*, a podetium or new shoot complete in itself (carpophore). Both podetia and apothecia are of ascogenous origin. *C. bacillaris* and *Papillaria* are diœcious. The following are the most important points regarding the power of producing shoots possessed by the apothecium.

3. The apothecium of lichens possesses the property of putting out apothecial shoots at any spot, viz. *a*, from the hymenium, in *Cladonia Papillaria* and *Lecidea Pilati; b*, from the periphery of the paraphysal

* Bot. Ztg., xl. (1882) pp. 65–83, 85–99, 105–16, 121–42 (2 pls.).

tissue, or excipulum proper, in *Pertusaria ; c*, from the hypothecium, in *Phlyctis*.

4. From this power of producing shoots must be distinguished the division of the apothecium, by which, in *Pertusaria*, the isolated portions of the apothecium are produced, and in *Gyrophora* those chambers, each of which, separated from the others by a circular wall, must also be regarded as a thallus-apothecium.

5. In *Pertusaria* no paraphyses are formed; the asci are developed directly in the original tissue.

6. In *Phlyctis agelæa* the paraphyses begin to shoot while the asci are dying off, and thus again take part in the formation of the thallus.

7. The apothecium of *Phialopsis*, at first entirely angiocarpous, is subsequently rendered gymnocarpous by secondary processes.

Structure of Crustaceous Lichens.*—J. Steiner has carefully studied the structure of the thallus of crustaceous lichens, especially in the cases of *Verrucaria calciseda* and *Petractis exanthematica*. He finds two ways in which the gonidia are formed. The first is an endogenous mode, by division of the entire protoplasm of the hyphal cells, after it has surrounded itself with a new membrane. The other is a kind of free-cell-formation, several daughter-cells being formed simultaneously in the protoplasm of the mother-cell. The author also finds that micro-gonidia (of Minks) are formed in the mother-cell by free-cell-formation. He uses chromic acid largely in his preparations.

Cœnogonium and the Schwendenerian Theory.†—The genus *Cœnogonium*, established in 1820 by Ehrenberg, comprises about twenty species which grow in the warm regions of the two hemispheres. The filamatous elements of the thallus present a great resemblance to the filaments of *Conferva*, and Dr. Karsten and Professor Schwendener recognized in 1862 that around some large confervoid filaments there exist other filaments much more slender, having a diameter of about 1–2 μ, which appear to be hyaline, and which creep in some measure on the surface of the large green filaments. There is but one single series around the green filaments, and yet this series is interrupted, the slender filaments not touching laterally in a regular manner, but often showing some anastomosis, and there occasionally form, at least in places, a rather close network. Hence there are two constituent elements in the thallus of *Cœnogonium* as in other Lichens, the large green cells still enclosed in their mother-cells, corresponding to the gonidia, and the slender hyaline filaments corresponding to the hyphal filaments.

It is clear, then, writes Dr. J. Müller, "that according to the celebrated theory of Professor Schwendener, announced in 1867, the large green filaments will represent the nourishing alga, and the

* Programme k. k. Staats-Obergymnasiums, Klagenfurt, xxxi. (1881) (2 pls.). See Bot. Centralbl., viii. (1881) p. 228.

† Arch. Sci. Phys. et Nat., 1881, p. 370. Ann. and Mag. Nat. Hist., viii. (1881) pp. 427–9. Grevillea, x. (1882) pp. 87–9.

slender hyphal filaments will be the parasitic fungus, the two forming together the thallus of a plant which should no longer, because of this union, have its legitimate place amongst the series of the classes of plants."

In examining a new species, *C. pannosum*, from Brazil, Dr. Müller claims to have discovered "a remarkably demonstrative case," which confirms the general results recently published by Dr. Minks.

One of the filaments in a great part of its length measured 8 μ in diameter, and was composed only of a large green tube similar to the large green tube of other filaments of the same stratum, and contained the cylindrical green gonidia which simulated some articulations of *Conferva* and is the alga of the theory. But at a certain point this tube suddenly narrowed and became a very slender capillary tube only 2 μ in diameter, without there being any discontinuation of the cavity, the whole forming one single cell, at first large and afterwards very narrow, perfectly similar to the slender hyphal tubes of the theoretic fungus which enclose the large green tubes or theoretic alga in other filaments of the same species. The capillary part, moreover, showed clearly the microgonidia in their natural form, size, and arrangement. "It follows that one and the same cell would have been the theoretical alga on the enlarged gonidia-bearing side and the theoretical fungus on the other side which remained narrow and contained microgonidia, thus proving in the most absolute manner the falsity of the theory, as the same cell cannot at the same time belong to two classes of plants. There is neither fungus nor alga; the whole is lichen, nothing but lichen; and the two kinds of tubes. so different at the first glance, are only different states of evolution of one individual organ. The very slender hyphal tubes are the first part containing the microgonidia. This first part may remain always in this state, or it may also enlarge and lengthen, while the microgonidia, originating by free-cell-formation, may pass into the stage of gonidia, and then the narrow hyphal tubes will become large gonidia-bearing tubes."

Algæ.

Crystalloids of Marine Algæ.* — J. Klein states that the crystalloids found in marine algæ are of two kinds:—(1) Colourless or less often brown crystalloids, occurring in the living cells as a constituent of their cell-contents, and differing in no essential respect from the crystalloids of other plants; and (2) crystalloids of a carmine-red colour formed only by the action of certain reagents, as sodium chloride, alcohol, or glycerin, on the cell-contents of the Florideæ, or occasionally formed outside the cells—the rhodospermin of Cramer.

Of the first kind Klein describes the crystalloids found in 20 species of marine Algæ, 5 of them green, the other 15 belonging to the Florideæ; they differ greatly in form and size, two or three modifications sometimes occurring in the same species. They are found within the parietal protoplasm, floating in the living cell, in the

* Pringsheim's Jahrb. f. wiss. Bot., xiii. (1881), pp. 23–59 (1 pl.). Cf. this Journal, iii. (1880) p. 494.

cell-sap. They are all coloured brown by alcoholic solution of iodine, and show the other ordinary reactions of proteinaceous crystalloids. They occur most abundantly either in very large-celled Algæ like *Cladophora* and *Griffithsea*, or in those the vegetative thallus of which is unicellular, as *Acetabularia*, *Bryopsis*, *Codium*, and *Dasycladus*; their size and number being apparently dependent on the size of the cells in which they occur. They appear to result from the development in the cells of an excess of proteinaceous substances. In some instances, as *Acetabularia*, where they are found only in specimens in which there are no spores, they are used up in the formation of the spores.

Rhodospermin has been observed by Cramer and Cohn in *Bornetia secundiflora*, *Callithamnion caudatum*, *C. seminudum*, and *Ceramium rubrum*, in which Algæ it is formed by the long-continued action of the reagents named. What appear to be immature crystalloids of rhodospermin have also been detected by Klein in specimens similarly treated of *Griffithsea phyllamphora* and *Phlebothamnion versicolor*.

Phyllosiphon Arisari.*—This organism, parasitic on the leaves of *Arisarum vulgare* in Italy, was first observed and described by J. Kühn, who regarded it as a Siphonaceous Alga allied to *Vaucheria*. Schmitz has also investigated it, chiefly in reference to its multinucleated cells, and considers it to be a fungus constituting a special group of the Phycomycetes. L. Just has now undertaken a complete investigation of its structure and life-history.

The parasite causes well-defined light-green or yellowish patches on the leaves and leaf-stalks of the host, each patch being inhabited by a single individual, which attacks the intercellular spaces only. Each individual consists of a single entirely undivided but often much-branched interwoven hypha, averaging about 0·05 mm. in diameter.

The young apices of the branches contain no chlorophyll, but a colourless protoplasm rich in larger or smaller granules (microsomes) and containing vacuoles and drops of oil. Further from the apices of the branches, the hypha is gradually more and more deeply coloured by chlorophyll, and contains a larger quantity of oil. When the spores are about to be formed, a parietal layer of protoplasm becomes nearly homogeneous, and comparatively free from oil-drops, while a layer of protoplasm next to this gradually breaks up into numerous minute portions, which clothe themselves with cellulose-coats, and develope into the spores. The innermost central portion of the protoplasm is rich in oil, but contains comparatively few granules and no chlorophyll; it absorbs water greedily and swells up. The escape of the spores takes place from ten to fourteen days after the first appearance of the patches. Just confirms Schmitz's statement of the occurrence of a large number of nuclei in the hyphæ; but he did not, like Schmitz, at a subsequent stage find one in each spore; the spores are entirely destitute of nucleus.

The spores are of oval form, averaging about 5 μ in length and 2·5 μ

* Bot. Ztg., xl. (1882) pp. 1–8, 17–26, 33–47, 49–57 (1 pl.).

in diameter; and at the time when they are formed the hyphæ are found to contain large quantities of starch, which is partly used up in the formation of their cellulose-wall, and which is no doubt derived from the oil that is present at an earlier stage; the spores themselves do not contain starch. Portions of the hyphæ remain colourless, and in these no spores are formed.

Although *Phyllosiphon* is found only in the intercellular spaces of the leaf and leaf-stalk of the host, the protoplasmic contents of the neighbouring parenchymatous cells undoubtedly supply it with nutriment, and it must be regarded as a true parasite. The intercellular spaces become in time entirely occupied by it, so that the respiration of the host must be greatly impeded.

As soon as the spores are completely formed in a portion of a branch, they escape spontaneously, the expulsion being caused by the great capacity for swelling possessed by the central portion of the protoplasm, the parietal layer at the same time contracting, and being ruptured in consequence. There is always, however, a certain proportion of the spores left behind in the hypha, surrounded by a portion of the protoplasm, and connected with one another by fine bands of protoplasm. The portions of the hypha which burst are frequently immediately beneath stomata, through which the spores are forced. This takes place chiefly on the under side of the leaf, the hyphæ forcing themselves only rarely and with difficulty between the comparatively closely packed palisade-cells which lie beneath the epidermis of the upper surface. The expulsion is effected with great energy, the spores being forced on to the external surface of the leaf. Those which remain in the hyphæ continue to grow, some of them attaining the size of 8 μ diameter and more; while others remain about the size of the expelled spores.

That the green colouring-matter of *Phyllosiphon*, although not occurring in the form of distinct grains, is chlorophyll, is beyond doubt; an alcoholic solution shows all the characteristic spectroscopic properties of this substance. It appears certain that this chlorophyll is not derived directly from that in the leaf-cells of the host; but that it is formed by the organism itself. Its purpose appears to be not to decompose carbonic acid in the hyphæ, but to pass entirely into the spores, which carry on an independent development outside the host, and require the chlorophyll for this purpose.

All attempts at artificial germination of the spores failed, both of those that are expelled, and of those, whether larger or smaller, that remain in the hyphæ; as also did similar experiments with the hyphæ themselves. The reason of this failure is no doubt that the spores require to go through a period of rest before germinating. In nature this period of rest extends from the middle of March, when the patches are most abundant (no fresh ones being formed after the middle of April) till December, when they begin to appear again.

Until the complete life-history of *Phyllosiphon* has been followed out, its systematic position must remain in uncertainty. Schmitz's view, that it belongs to the Phycomycetes, must be entirely abandoned; nor does the mode of formation of the spores justify us in placing it, with Kühn, among the Siphonaceæ. Its parasitic character is the only point which gives countenance to the idea that it presents a transitional form between Algæ and Fungi. All that can be certainly stated of this organism is that it is an alga which inhabits the leaves and leaf-cells of *Arisarum vulgare;* and that its spores pass through a resting stage outside the host.

Structure of Corallina.*—Count Solms-Laubach has carried on a series of observations, in the zoological station at Naples, on the structure of *Corallina* and its allies. The strong calcification of the cell-walls, and the scarcity of the sexual plants, present great difficulties in the way of their examination.

There is no difference in the origin of the tetrasporangia and of the conceptacles of the sexual organs in *Corallina.* The apex of a shoot first of all becomes depressed, and then hollowed out with a more or less narrow opening. At the bottom of this cavity are found, in the tetrasporangia, elongated cells, the transverse division of which produces the tetraspores with intermediate paraphyses. The conceptacles which produce the spermatia bear a close resemblance to the spermogonia of fungi. The filaments which bear the spermatia project from the opening; at their extremities are from two to four minute cells, each of which bears a tuft of very fine sterigma-like threads; and from these sterigmata the spermatia are separated by abstriction. When free the spermatium appears as if tailed, from a piece of the sterigma still remaining attached to it.

The procarps are formed from the cells which make up the floor of the conceptacle. Their development advances from the centre towards the margin; but while the central trichogyne becomes in the meantime prepared for impregnation by a club-like swelling at its apex, they become smaller and less frequent towards the margin, and the outermost procarps of all have no trichogynes in a receptive condition. Notwithstanding this, the production of spores commences with the marginal procarps. While in the majority of the Florideæ each procarp produces a cystocarp, in *Corallina* only one is formed in each conceptacle, resulting from the development of all the procarps. After impregnation all the carpogenous cells of the procarp coalesce laterally by resorption of the separating walls. The "carpogenous fusion-cell" thus formed developes the spores from its entire margin; in *C. mediterranea* club-shaped cells are produced in great numbers from the indented edge, are separated by a wall from the fusion-cell, and produce the spores by transverse division. This process exhibits a hitherto unknown variety in the mode of producing fruit, resembling in some respects that in *Dudresnaya.*

The author draws a comparison between the "sister-procarps" of *Dudresnaya*, and the oosphere and synergidæ or "sister-archegonia" of Angiosperms.

The treatise concludes with a description of the allied genera *Amphiroa*, *Melobesia*, *Lithophyllum*, and *Lithothamnion*, especially as

* Graf zu Solms-Laubach, 'Corallina: eine Monographie,' 1881 (3 pls.). See Bot. Ztg., xxxix. (1881) p. 795.

regards the mode of formation of the fruit. A new species, *Melobesia deformans*, is described as parasitic on *Corallina natalensis*, in which, instead of the usual regular pinnate structure of the apex of the thallus, it branches in all directions into short irregular branches. *M. callithamnioides* produces peculiar gemmæ, reminding one of those of the Sphacelarieæ.

Impurities of Drinking Water caused by Vegetable Growth.*—W. G. Farlow gives a résumé of what is known respecting the vegetable substances which cause impurities in drinking water. The most injurious are the blue-green algæ the Phycochromaceæ, but only after death. They do not, however, produce infectious diseases; *Beggiatoa* gives off sulphuretted hydrogen. The following are described in detail:—*Cœlosphærium Kutzingianum, Clathrocystis æruginosa, Anabœna flos-aquæ*, and *Lyngbya Wollei.*

Fossil Siphoneæ.†—Meunier-Chalmas has determined the eocene genus *Ovulites* to be identical with *Penicillus* Link., *Nesea* Lmx., and *Coralliodendron* Ktzg., from which he establishes a new section of Siphoneæ, distinguished by their dichotomous branching. One of the eocene species is closely allied to the existing Mediterranean *Coralliodendron mediterraneum.* These were previously regarded as constituting a class of Protozoa, under the name Dactyloporideæ, to which also belongs *Triploporella*, found by Steinmann in the calcareous beds of the Lebanon.

Falkenberg's Algæ.‡—In his new 'Handbook of Algæ,' Falkenberg follows in the main de Bary's classification §; but introduces the doubtful innovation of calling one of his four classes (including Melanophyceæ and Chlorophyceæ) Algæ in a restricted sense. The author uses the term "gametes" for any masses of protoplasm, in both Thallophytes and Archegoniatæ, union of which constitutes a reproductive act, including therefore oospheres and antherozoids; the result of this union, whether hitherto known as zygospore, oospore, or fertilized ovum, he calls a "zygote." In the Florideæ we have a distinct mode of fertilization, viz. the impregnation of a multicellular female organ, the "procarp," which developes into the fructification containing the carpospores. The larger and smaller groups are described with great clearness and an admirable selection of the salient characters; there is copious reference to the literature of each section; and the illustrations, though not very numerous, are excellent, many of them being new. Unfortunately there is nothing in the shape of an index.

Motion of Diatoms.||—Mr. C. M. Vorce, while being unsatisfied with any of the theories advanced and having none of his own,

* Suppl. to First Ann. Rep. of Massachusetts Board of Health, 1880, pp. 131–52 (2 pls.).

† Bull. Soc. Geol. France, vii. (1881) pp. 661–70. See Bot. Centralbl., viii. (1881) p. 270.

‡ Falkenberg, P., 'Die Algen in weitesten Sinne,' Breslau, 1881 (Encyklopädie der Naturwissenschaften, 1te Abtheil., 23 Lieferung).

§ See this Journal, i. (1881) p. 273.

|| Amer. Mon. Micr. Journ., iii. (1882) pp. 43–5.

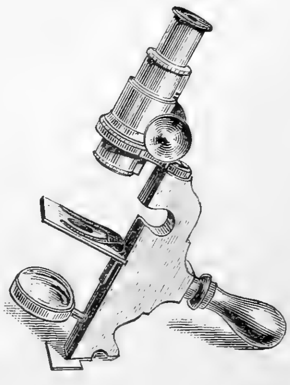
records some of the results of his observations. Many of the phenomena connected with the motion of diatoms, indicate that the frustules are enveloped in a membrane which, if adhesive, would cause many of the appearances noted, provided the motion be accounted for. Where extraneous matter is seen trailing after a diatom it is, however, as likely that the adhesive property resides in it as in the diatom. The remarkable alternation of motion seems a very strong objection to the ciliary theory and equally so to that of prehensile filaments. No other ciliated or flagellate organism exhibits such alternations. Not even in the case of large diatoms when moving with great force can any trace of cilia or filaments be seen. If ciliary action or currents produced by osmose were the true explanation, we should expect them to move adjacent particles when the diatom is held fast, but yet free particles are not moved nor is there any evidence of current in the water, except where it is in contact with the diatom. In fact, none of the suggested causes of motion explain satisfactorily all the phenomena observed, and the problem still lies open to some persevering observer.

MICROSCOPY.

a. Instruments, Accessories, &c.

Griffith's Portable Microscope.*—Mr. E. H. Griffith has further modified this instrument, which now "has the usual coarse adjustment by rack and pinion, which is very accurately made, and by an ingenious addition, serves also as a fine adjustment. A ring is mounted on the axle of the hand-wheel; a set-screw clamps the hand-wheel when the coarse adjustment is effected, so that it cannot be moved, and all danger of breaking the slide is avoided. Then a lever working in the ring moves the tubes by means of the same rack and pinion. As the lever is itself moved by a worm-screw, it forms a very exact and delicate focussing arrangement."

FIG. 61.



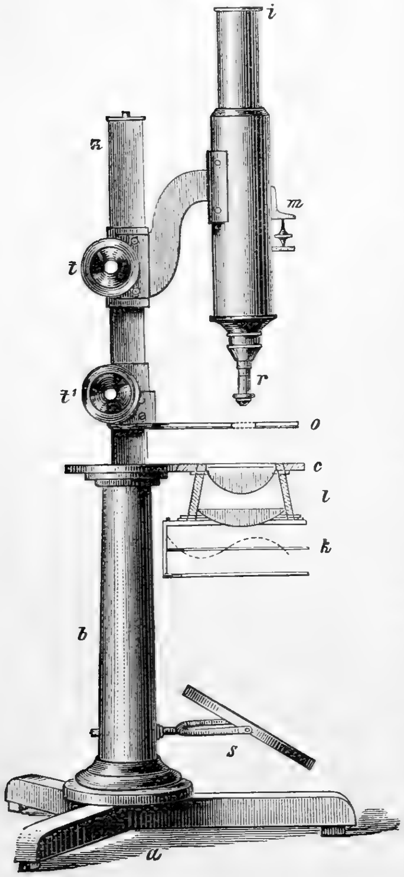
Parkes' Class Microscope.—Messrs. Parkes have adapted the Microscope described *ante*, vol. i. (1881) p. 655, for use as a Class or Demonstrating Microscope. It is shown in Fig. 61. The handle, in conjunction with the base of the stand, enables it to be placed on a table in the ordinary way when so desired. The condensing lens more usually employed when the instrument is being handed round a class can be replaced by a mirror.

Pringsheim's Photo-chemical Microscope.—Professor Pringsheim's researches on the functions of chlorophyll in the life of the

* Proc. Amer. Soc. Micr., 1881, p. 85.

plant, and the connection of its production and destruction with the intensity of the light, have been already fully described,* and we now add Dr. A. Tschirch's description † of the special Microscope which Professor Pringsheim constructed for observing the effect of a high intensity of light on objects directly on the stage, and to carry out his method of "microscopical photo-chemistry"— a method which he considered would also be valuable in investigating the action of light on protoplasm and the formed constituents of the cell-body, for investigations on the sensations of heat in the lowest animals, and in certain cases for ascertaining the truth respecting the presence and seat of the perception of light.

Fig. 62.



The instrument is three times larger than the ordinary [German] Microscopes, and its form resembles that of the older Schieck stand. Upon a firm tripod *a* rests the conical column *b*, to which is fixed the large round mirror *s*. The latter is 160 mm. in diameter, and is as strictly plane as possible. It receives the sunlight from a heliostat, whose mirror must be considerably larger than that generally used, so that the mirror of the Microscope may be fully illuminated at any altitude of the sun; 235 mm. by 165 mm. is a sufficient size. At a distance of 165 mm. above the mirror, the column supports a large stage *c*, about 110 mm. square, beneath which the lens-system is screwed for the production of the sun's image. In the instruments hitherto employed, a doublet of two plano-convex lenses is made use of, placed in the same frame *l*, 28 mm. from each other. The lower has an aperture of 66 mm. and a focus of 93 mm., the aperture of the upper being 48·4 mm. and the focus 35 mm. In this position they form a round image of the sun 0·35 mm.

* See this Journal, iii. (1880) pp. 117–19, 323–4.

† Zeitschr. f. Instrumentenk., i. (1881) pp. 330–3 (4 figs.).

in diameter, and although the lenses are not perfectly achromatic, yet it is not too strongly coloured at the margin by chromatic aberration.

Below the doublet another piece of apparatus can be screwed with either two springs, or better a double fork *k*, for holding the coloured solutions or glasses for producing monochromatic images, also the media for the absorption of the dark heat-rays. If it be required to have additional vessels for the absorption of heat or to employ different absorption media at the same time, others can easily be fastened under the forks by indiarubber rings, the height of the stage *c* above the mirror giving sufficient space for four or five. It is not advisable to fix them above the lenses upon the stage *c*, because while the warmth beneath the lenses extends uniformly through the whole of the fluid, there is above them a very hot cone of rays, which strongly heats a small portion of the absorption liquid, and with liquids such as iodine in bisulphide of carbon explosions may easily take place. Indeed, it is in this case necessary, instead of the Desaga bottles (at first exclusively employed by Professor Pringsheim), to use glass boxes for holding the absorption fluids, of greater width than the aperture of the doublet. For this purpose round, well-polished glass rings can be employed, 10 mm. deep, closed on either side by flat glass plates, held together by strong indiarubber rings. If these are carefully closed, all aqueous solutions can be kept in them for months without evaporating to any considerable extent, particularly as a stratum of small crystals speedily forms at the edge, and thus makes them still more air-tight. Solutions of bisulphide of carbon must often be renewed, because they evaporate, even when most tightly closed.

After many experiments, the following have been proved to be the best absorption fluids:—For the absorption of red-yellow, a solution of ammonio-oxide of copper; for the blue and red ends of the spectrum, solutions of chloride of copper, obtained by the evaporation of a saturated solution of the salt, according to the intensity of the colour and the extent of the absorption; for the green-violet, a solution of bichromate of potassium ($K_2Cr_2O_7$); and for the orange-violet a solution of iodine in bisulphide of carbon or iodine in iodide of potassium. As far as can be at present ascertained, solutions of organic pigments or of aniline colours are unsuitable, at least they possess no superiority over the above solutions. Coloured glass plates may be used, if perfectly uniform. Of course, the value of all media for absorption must first be tested in the spectroscope. Water or a concentrated solution of alum can be used for the absorption of the dark heat-rays.

Above the fixed lower stage is the movable stage *o*, moved by the screw t^1. It is pierced in the centre, and serves to carry the slide, the gas chambers, &c. By means of the screw, the object can be brought into the plane of the sun image formed by the lenses, or immersed in it if necessary. The screw t^1, as well as *t*, which moves the microscope-tube, works on a triangular bar *z*. The screw *t* gives the coarse focussing, after the object on the stage has been adjusted by means of t^1, whilst the micrometer-screw *m* gives the necessary fine focussing movement. The objective is shown at *r*. (The author says that it is better to produce the fine adjustment by means of a screw on the end of the tube, similar to the correction adjustment of objectives.)

To be able to produce a clear image of the sun, the whole of it must be seen, and therefore only low powers can be used. The field must be about 1 mm. in diameter. To protect the eye against the intensity of the light, a number of smoked glasses can be placed on the eye-piece *i*.

Two methods were employed by Professor Pringsheim for the temperature determinations *: (*a*) the insertion of a thermo-electric couple of iron and nickel into the drop, the results being read off by a galvanometer; and (*b*) the introduction of small crystals of substances of known melting-point. For the latter purpose two substances, azoxybenzol, which melts at 45° C., and mint-camphor, with its melting-point 35° C., were found most convenient.

Waechter's (or Engell's) Class or Demonstrating Microscope.—This instrument might readily be mistaken for an ordinary brass candlestick. Its original form is figured by Harting †; Figs. 63 and 64 show it as improved by Waechter, the lower part being seen in Fig. 63 *in section*.

Fig. 63.

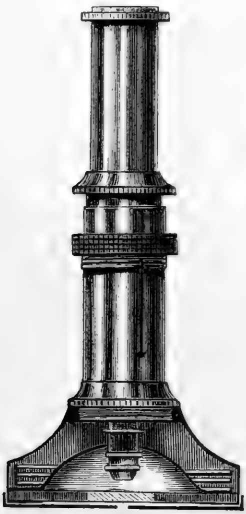
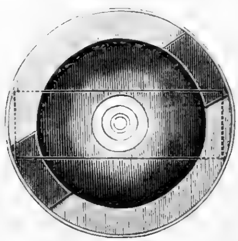


Fig. 64.



The body-tube, carrying eye-piece and objective, slides in an outer "sprung" tube which is attached at its lower end to a conical base, which forms a wide support for the instrument to stand upon when not in actual use. The inside of the base is polished so as to reflect light upon opaque objects. The ends of the slides are held beneath a metal ring at the lower end of the base, as shown in Fig. 64, and they can be removed by turning them round till they coincide with the two openings in the ring. The instrument is held up to the light and focussed by sliding the inner tube in the usual way. It can be secured at any given focus if desired by the milled clamp ring near the top of the sprung tube. A cover fits over the base (shown in Fig. 63) and is pierced with a small hole to act as a diaphragm with high powers.

The instrument is intended for class demonstration.

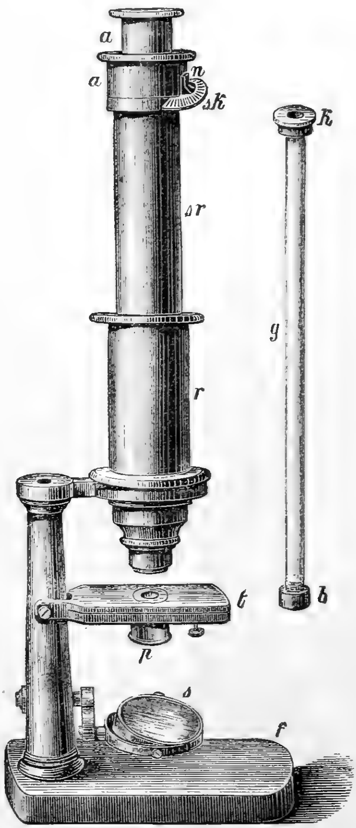
* See translation of Prof. Pringsheim's Researches by Prof. Bayley Balfour, Quart. Journ. Micr. Sci., xxii. (1882) pp. 76–112 (2 pls.).

† Harting, P., 'Das Mikroskop,' iii. (1866) pp. 196–7 (2 figs.).

Wasserlein's Saccharometer Microscope.*—This instrument is shown in Fig. 65, and its special feature (though one of very doubtful advantage) is that it enables one and the same instrument to be used as an ordinary Microscope and as a saccharometer.

The following is the method of using it:—The diaphragm having been removed from the stage *t*, and the polarizer *p* substituted, the body-tube (with eye-piece and objective) is taken out of the tube *r*, and the saccharometer-tube *sr* inserted so that its lower end is close over the polarizer. The latter tube has at its upper end, and on one side, a semicircle *sk* fixed at right angles, on which is a scale graduated up to 25° from the centre on either side. The analyzer *aa* is inserted, and the mirror *s* arranged in the usual way for microscopical observation. The nonius *n*, attached to the analyzer, is then adjusted by turning the latter so that the centre division of the nonius exactly agrees with the 0° of the scale, and the polarizer is revolved on its axis to the right or left until the so-called neutral point is reached, at which both halves of the field of view appear of equal intensity and colour. Removing the analyzer, the glass cylinder *g* (20 cm. long) is inserted into the saccharometer-tube (being first completely filled with clear solution of sugar or urine), and the analyzer replaced in its original position. On revolving it to the right or left until the neutral point is again reached, the nonius will now have another position on the scale, and its central division marks the degree, from which the percentage of sugar in the solution can be determined. A petroleum lamp is the best for the observation.

FIG. 65.



The glass cylinder *g* must be completely filled, so that after being closed by the cap *k* there are no air-bubbles.

The scale (not divided into 360° but into 180°) shows the quantity of glucose or grape-sugar direct.

* Cf. Hager, H., 'Das Mikroskop' (8vo, Berlin, 1879), pp. 45–7, 1 fig.

Wenham's Universal Inclining and Rotating Microscope.—"Another F.R.M.S." suggests* that there was one point in connection with this Microscope which has been omitted, and claims that the merit of the principle of construction is due to Dr. Edmunds, on the following grounds:—

"On November 10, 1880, at the Royal Microscopical Society, Dr. W. B. Carpenter exhibited and fully described a small rough stand made for students' purposes by Mr. George Wale, and the record of the proceedings of that meeting will be found in the Journal of the Society for 1880, p. 1087. From that published record I extract the following paragraph:—

'Dr. Edmunds pointed out that this most useful microscope-stand would be vastly improved if only the arc upon which the body turns were so constructed that the centre of the circle of which the arc forms part were made to coincide in position with the centre of the stage. The object would then undergo no movement of translation, either in rotating the stage or in turning the optical tube from the vertical to the horizontal In rotating the stage, the object would turn upon the optic axis; in moving the tube into various degrees of obliquity from 0° to 90°, the object would rotate upon its horizontal axis. The result would be that, with a thin stage and a hemispherical lens in immersion contact with the under surface of the slide, all the complicated swinging substages and other contrivances now upon the table might be swept away, and every angle of illumination could be got by merely inclining the body of the Microscope upon its sustaining arc. There would only be needed a lamp on a level with the object, with a condenser at its focal distance standing upon the table in line between the lamp and the object.'"

The writer, in some criticisms of the design, insists that with the object centered upon a revolving stage and *one* movement in altitude, all possible illuminations are at command.

Mr. Wenham subsequently writes † denying that he had previously read Dr. Edmunds' remarks above quoted, and stating that his own Microscope was designed before their date.

A similar disclaimer is made ‡ by Mr. J. M. Moss, the designer of the Microscope described in this Journal, i. (1881) p. 516.

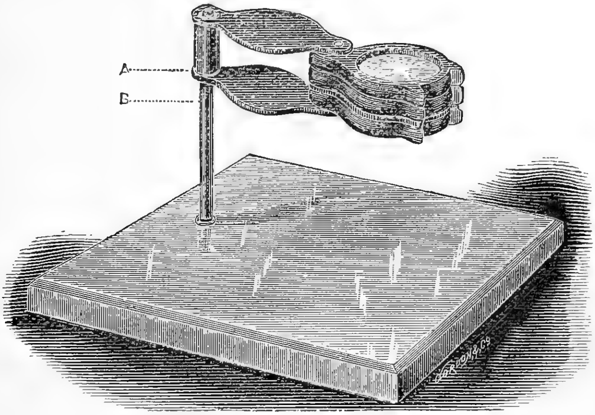
Brücke Lens.—Mr. A. Smith points out, with reference to our description of this lens, *ante*, p. 101, that it is also described in Rutherford's 'Outlines of Practical Histology,' 1876, p. 36, and figured, with a holder, on p. 38.§ Our sectional woodcut, Fig. 14, was unfortunately reversed by the printer.

Bausch and Lomb Handy Dissecting Microscope.—This instrument (Fig. 66) made by the Bausch and Lomb Optical Company, for use in mounting Foraminifera or other objects which have to be

* Engl. Mech., xxxv. (1882) p. 217.
† Ibid., pp. 237 and 282. ‡ Ibid.
§ It is also referred to by Dr. Carpenter, 'The Microscope and its Revelations,' 1881, pp. 58–9.

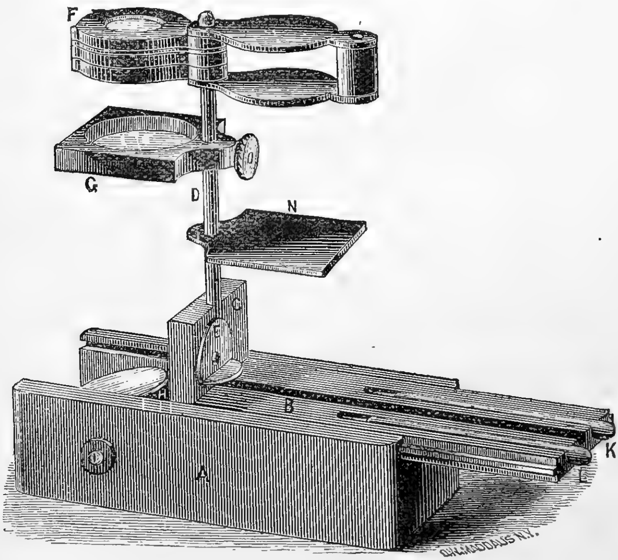
selected from sand and other débris, differs from other similar forms in that the base (into which the steel stem supporting the lens is screwed) is made of a thick plate of glass, so that by placing a sheet

FIG. 66.



of white paper beneath it, and using a bull's-eye condenser, opaque objects can be easily selected for mounting.

FIG. 67.



Excelsior Pocket and Dissecting Microscope.—This instrument patented by J. J. Bausch (Fig. 67) comes from the United States, where it has been several times described. It consists primarily of a small wooden case A, about one-third larger than shown in the figure. To one end of the lid B is attached one of the ends C of the case, and when the lid is reversed it may be slid into the groove of the case, and then forms a stand for the lenses and stage. These are supported by a steel rod D, the lower end of which is hinged to the lid so that it may be turned down and lie in the groove provided for it. When raised into the position shown in the figure, it is held securely in place by means of the button E, which also serves to retain it in the groove when it is turned down. The glass stage G is fitted into a frame of hard rubber, and slides easily on the stem D, so as to be readily adjustable for focus, while at the same time it may be firmly fixed by means of a set-screw, at any desired height, and will then serve as a stage for dissecting purposes. The frame which holds the lenses F (magnifying 5–30 diameters) fits on the top of the stem. A mirror H is fitted into the case, and is readily adjustable by means of the button I shown on the outside, so that light may be reflected up through the stage when the objects to be examined are transparent. When they are to be viewed by reflected light there is a dark plate of hard rubber N, which is also carried by the stem D, and may be turned under the stage so as to cut off all transmitted light. Dissecting needles (K and I), with handles, fit into appropriate grooves.

The glass plate is fitted into the stage so as to form a cell capable of holding water, so that dissection may be carried on under that liquid, or aquatic animals may be kept alive and examined at leisure. The stage may also be turned so that the flat side will be uppermost if desired. When the lenses and stage are removed they are readily packed in the case, and the entire instrument goes into a compass "which readily admits of it being carried in the vest pocket."

Dr. Phin recommends * that in order to increase the steadiness of the instrument the case should be attached to a board 6 in. × 4 in. × $\frac{3}{4}$ in. A single small screw is sufficient, and the board can be easily detached when it is desired to carry the Microscope in the pocket.

Hartnack's Drawing Apparatus (His's Embryograph).†—Dr. E. Hartnack describes his new drawing apparatus, which is a modification of the embryograph of Professor His. He writes:—"It is desirable for many purposes of natural history to trace exact outline drawings with low magnifying-powers, and to be able to regulate the power so that it may be easy to pass from one scale to another. The drawing apparatus hitherto employed in microscopy (even with the use of low objectives) have hardly allowed the use of a power less than 20; moreover, although through the movement of the tube it was not impossible to obtain any scale desired, yet, at any rate, it was not convenient.

"A short time ago Professor W. His published ‡ the design of a drawing-apparatus which allowed the power to be varied at will from 4 to 40. He combined the Oberhäuser camera with a small photo-

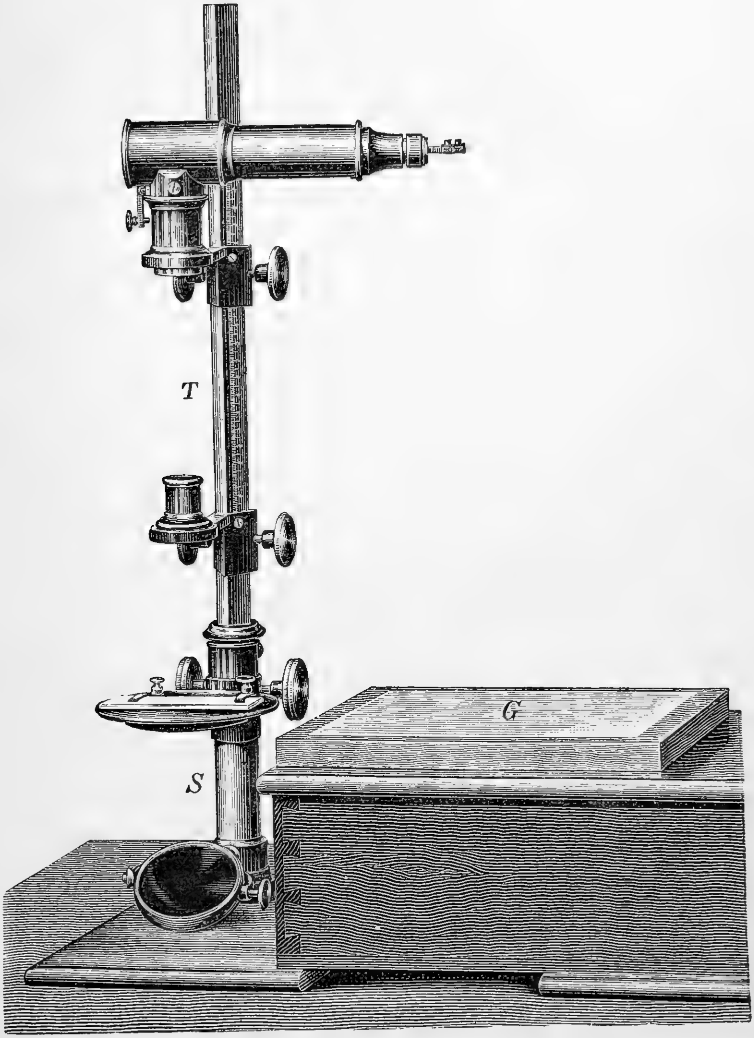
* 'How to use the Microscope,' 4th ed., 1881.

† Zeitschr. f. Instrumentenk., i. (1881) pp. 284–7 (1 fig.).

‡ 'Anatomie menschlicher Embryonen,' fol., Leipzig, 1880.

graphic objective in such a manner, that both could slide backwards and forwards in movable sockets, on a bar 60 centimetres long, provided with a scale. The bottom of the bar bears the movable

Fig. 68.



object-stage, and under this is a microscope mirror. A glass plate placed at the side of the apparatus acts as the drawing surface.

"This apparatus has been employed for years by Professor His, but I have endeavoured to give it a more compendious form, and at the same time to extend its magnifying power still more. In this I have succeeded by employing different objectives for the lower and higher powers, so that it was possible to reduce the height of the apparatus by a third."

The accompanying figure shows the apparatus (Fig. 68), S being a circular column, and T an angular bar, the latter divided into millimetres. G is the drawing plate placed on the box (38 × 22·5 × 9·5 cm.) in which the apparatus packs by separating the pedestal, column and bar, the stage, &c.

Professor His writes to Dr. Hartnack as follows as to the use of the apparatus:—"Your form is thoroughly serviceable, and allows of correct and convenient working with powers of 4 to 70. According to your request I append some information as to its management. The regulating of the magnifying power is the first thing to be attended to by means of a scale divided into half-millimetres as an object. The stage must be placed in its highest position, and the objective and the prism moved until the image projected upon the glass plate shows the desired magnifying power. . . .

"For a power of 4, the stage must be pushed downwards 20 mm., and in order to take in the whole of the field of view with powers of 4 or 5 it must be unscrewed from its ring and the latter used as the stage.

"The aperture of the stage is only 20 mm.; short or long-sighted people should always use the same spectacles. When the desired power has been determined the object to be drawn is placed on the stage, and focussed *only* by moving the latter. In order to obtain a distinct image, the object must be in the same plane as the numbers and strokes of the scale were previously, and if this is obtained by unaltered position of the objective and prism, the magnifying power of the whole apparatus must remain the same as before, the distance of the drawing-surface from the objective remaining unchanged."

[Some general remarks follow as to testing the objectives, the regulation of the light, &c.]

"Opaque objects are best drawn in liquids. My chief object being to draw embryos, I have had unpolished hollow vessels of black glass or marble made, 5–20 mm. in depth; the embryos were covered with alcohol and a thin glass plate placed over them in such a manner as to exclude air bubbles. If it is necessary to keep the embryo in a given more or less depressed position, this can be done by using small strips of glass suitably bent.

"The above directions will perhaps suffice to assist the inexperienced in the use of the apparatus, and I only hope that others may find it, in the elegant and convenient form which you have given it, as useful as I have done."

Drawing from the Microscope.*—Mr. W. T. Suffolk dispenses entirely with the camera lucida, and substitutes a grating ruled in squares and placed over the diaphragm of the eye-piece. It is better

* Sci.-Gossip, 1882, pp. 49–50.

to have the lines ruled on a double-convex lens of shallow curvature, as the interference with the definition is considerably less than when a glass with plane surfaces is used: with this arrangement Podura-markings can be well shown with a $\frac{1}{8}$ objective. When the binocular is required, a lens without ruling, but of similar curves, should be placed in the other eye-piece to equalize the magnifying power in each field. A convenient distance for the lines is $\frac{1}{20}$ inch, this gives a field not too much crowded with squares, and on the other hand the divisions are not too large to render the setting out of the outline inexact. The drawing is made on ruled paper, the squares being of a size suitable to the intended size of the design, just as in the well-known draughtsman's process of enlarging and reducing by squares. A drawing of any size, from a small sheet to a large lecture diagram, can thus be made directly from the Microscope.

The process also possesses the additional advantage of requiring no change in the position of the Microscope, as is the case with the camera-lucida, and can be used for a long time without any of the strain upon the eye inseparable from the use of instruments, where the image and pencil point are viewed through the divided pupil of the eye.

With regard to materials, Mr. Suffolk takes exception to the use of *flake white* for compounding body colours, as in water all pigments made of carbonate of lead rapidly become blackened. Chinese white, a preparation of oxide of zinc, should alone be used for this purpose. He also gives the following list of colours which he considers will be found sufficient for nearly every purpose:—aureolin,* yellow ochre, lemon yellow, cadmium yellow, vermilion, purple madder, raw sienna, burnt sienna, rose madder, light red, brown madder, cobalt, French blue, indigo,† vandyke brown, blue black, sepia, viridian.‡ In addition to the colours in cakes, a few that are likely to be used in large quantities should be obtained in tubes; where thick painting is required, this form of colour is particularly useful. The Chinese white should be kept in a bottle with a greased stopper; in tubes it soon hardens and becomes unfit for use; it should be worked with the palette-knife and a little water to the consistency required.

The use of crimson and purple lakes, carmine and all other cochineal colours should be avoided; the madders are the only safe substitutes. Iodine, scarlet, the chrome yellows, and all aniline colours, should find no place in the colour box.

Very good effects are obtainable by the use of blacklead, and

* Aureolin, a transparent pure yellow, quite permanent, and an excellent substitute for gamboge, as, being without gloss, it can be employed in skies and distances.

† Indigo is only very slowly acted upon by light, and may be considered permanent in the diffused light of an ordinary room; avoid mixing with Indian red, which speedily destroys it.

‡ A transparent oxide of chromium, perfectly permanent, of great use both by itself and in compounding other greens; the opaque oxide of chromium may also be found useful; both are extremely permanent colours.

for rapid work it offers many facilities. In addition to pencils of the usual kind, some with broad leads will be found useful for covering larger surfaces. Very delicate tints can be made with blacklead powder rubbed on the paper with a suitable leather stump. Tints of any depth can also be obtained from blacklead used as a water-colour, which can be procured in cakes.

Blacklead, charcoal, and chalk drawings can be permanently fixed, by saturating the paper from behind with a varnish composed of bleached shellac and alcohol. This should be very freely applied and dried in a warm room or with caution before a fire. The strength should be such that it will just dry without leaving a gloss on the paper. Winsor and Newton's white lac varnish, mixed with an equal bulk of methylated spirit, will be the right strength. After this treatment a pencil drawing may be placed in the portfolio, and even exposed to some amount of rubbing, without injury. The varnish does no harm to any water-colour tints that may be used in combination with pencil.

Ulmer's Silk Thread Movement.*—J. Ulmer suggests the use of a silk thread for microscope-tubes and the eye-pieces of telescopes.

The tube T (Figs. 69–72) has above and below in the socket two guides *c c*, against which it is gently pressed by the small pulley *d* and spring *e*, by which means easy sliding is secured. The movement of

Fig. 69.

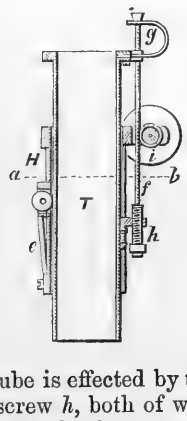


Fig. 70.

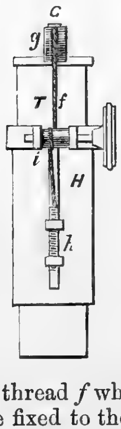


Fig. 71.

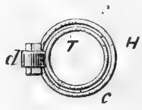
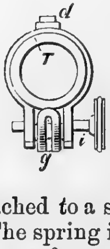


Fig. 72.



the tube is effected by the silk thread *f* which is attached to a spring *g* and screw *h*, both of which are fixed to the tube. The spring is slit as shown in the figures, and the screw is hollow and serves for stretching the thread and the spring, after the former has been laid in the slit, and turned round the pinion *i*, which is fluted to avoid slipping. The rotation of the tube is prevented by making the support by which the female screw at *h* is attached to the tube slide in a slit in H.

The apparatus works, it is said, without any "loss of time," and secures an easy motion, at the same time being very simple.

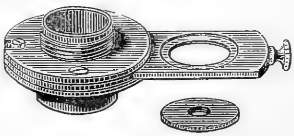
* Centralztg. f. Optik u. Med., ii. (1881) p. 148 (4 figs.).

Diaphragms for Limiting the Apertures of Objectives.—Mr. J. B. Dancer proposes * other forms of diaphragms for this purpose, the iris-diaphragm being unsuitable on account of the "ragged" outline which it gives. The first form is an oblong plate of diaphragms, which *slides* in an adapter screwed to the nose-piece, the second is a circular *rotating* plate.

The third method utilizes the ordinary double nose-piece. A shallow recess is made in the top edge of one of the female screw parts of the nose-piece to receive thin metallic (numbered) disks, having holes of suitable diameters. A disk with the required aperture can be dropped into the recess by merely moving the arm, which carries the objective, on one side. A wire hook is useful for lifting them out again.

A still later device is shown in Fig. 73, and is a combination of the first and third plans. An oblong plate slides in an adapter, but instead of being pierced with several apertures of different sizes, it has two apertures of equal size, into which can be dropped the various diaphragm disks used with the third plan. This gives great facility for removing and changing the diaphragms quickly, and might, we think, be usefully adapted for taking the diaphragms required for the diffraction experiments.

Fig. 73.



It must be observed, however, that the object for which the use of these diaphragms was suggested is not practically attainable. The suggestion was founded on the fact that a low-angled objective has greater penetrating power than a high-angled one, and it was considered that by using a diaphragm at the back of the objective, thus cutting down the aperture, an objective of wide aperture could be made to do duty as a narrow-angled one also; so that two classes of objectives were unnecessary. As Professor Abbe points out at p. 308, the plan adopted in the construction of wide-angled objectives will not allow of such a double use; and it is still necessary to employ two classes of objectives, using those of small aperture when penetration is required.

Correction-adjustment for Homogeneous-immersion Objectives.†—Dr. G. E. Blackham discusses the reasons suggested for dispensing with an adjustment to these objectives, viz. no risk of decentering, the existence of a *one best* position in all objectives, the cost of the adjustment, and the trouble of correcting.

To these objections the following he considers to be conclusive replies.

First, if the brass-work is done with a degree of skill at all commensurate with that necessarily expended on the glass-work of a really first-class homogeneous-immersion objective, there need be no fear of injurious decentering by the movements of the adjustment-collar.

Second, while it is true that the adjustment by means of varying

* North. Microscopist, ii. (1882) pp. 89–90, 92.

† Proc. Amer. Soc. Micr., 1881, pp. 61–4.

position of the systems 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.

Third, that while it is conceded that really first-class metal-work is expensive, if it can be shown that it is *necessary*, the objections to it must also fall.

The term homogeneous-immersion, though honestly applied and correct as to the *idea*, is only approximately true at present, as no truly homogeneous-immersion fluid has as yet been discovered, so far as the author can learn. That is, no fluid whose optical properties are *absolutely identical* with those of the front lens of any objective. The *refractive* power of crown glass has been closely approximated, but minute differences of *dispersive* power remain; and even if this difficulty could be overcome, the varying refractive and dispersive powers of various samples of crown-glass must always remain an unknown quantity in our problem, to be provided for by some kind of adjustment.

This fact has been recognized by at least one maker, who advises to correct for extremely thick or thin covers, by means of the draw-tube, and furnishes *two* fluids, one for use with direct central light, and the other with very oblique light. Of course it follows that for perfect accuracy of correction by means of the immersion fluid, a different fluid would be needed for each degree of obliquity of illumination. That this would involve serious inconvenience hardly needs demonstration; more especially when we consider that it is often desirable to examine an object under *gradually* varying obliquity of illumination, from direct central to the most oblique the lens can utilize.

Another point is the variation in the human eye; which must be compensated for in some way.

"It appears then, that the homogeneous-immersion system does not entirely obviate the necessity for adjustments of some kind, though it greatly lessens their *extent*. That these small residual 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 varying the distance between the objective and eye-piece by means of the draw-tube, or by varying the refractive and dispersive powers of the immersion medium by means of mixtures of various oils, &c., in varying proportions will, I think, on consideration be generally admitted.

But this greater ease, rapidity, and accuracy of adjustment with homogeneous-immersion (so called), is not the only argument in favour of the retention of the adjustable mounting for objectives. Most immersion fluids are apt to vary in their optical properties with their age or the state of the weather. One of the best of them, the solution of the sulpho-carbolate of zinc in glycerine, has its refractive power increased in very dry and decreased in very wet weather. In this case it is more convenient to turn the adjustment-collar slightly, than to make a new solution for immersion.

Again, it is often desirable to use an objective with a much longer or shorter tube than it was specially constructed for, or to use some other immersion medium than its own, water or glycerine for instance, for some special purpose. Here, again, the advantage, nay, the necessity, of the adjustable mounting, becomes evident. I believe then that I have shown:—

First, that homogeneous immersion has not been and is not likely to be more than approximately attained.

Second, that even if it should be fully attained, so far as the front lens of the objective is concerned, the varying refractive and dispersive powers of different eyes, and different samples of cover-glass would always remain to be accounted for.

Third, hence adjustment of some kind will always be necessary.

Fourth, that a well-made adjustable mounting for the objective is the most convenient, satisfactory, and perfect arrangement for this purpose yet devised.

Fifth, that by means of such an adjustable mounting the range of usefulness of an objective, as well as the convenience of using it are greatly increased, and therefore,—

Sixth, homogeneous-immersion objectives (so called or real), as well as all other objectives of wide angle, should be made adjustable."

Hitchcock's Modified Form of Vertical Illuminator.*—Professor R. Hitchcock suggests another form for a vertical illuminator, which, he thinks, will be better than the ordinary one, and more convenient for use.

"Instead of the reflector now used, a small glass reflecting prism is placed in the nose-piece in the same way and in the same position as the Wenham binocular prism, and in the case of binocular Microscopes should replace the latter. The back surface of the prism, which receives the light, may be either plane or curved; it might be found advisable to make this surface act as a lens to throw the light upon the back of the objective in the most advantageous manner for illumination. All parts of the prism not used should be blackened, so that no light except what passes down to the objective can enter the tube. A rotating diaphragm can be added, working in front of the exposed surface of the prism; but this would probably be an unnecessary expense."†

Flesch's Finder.‡—Dr. Max Flesch describes the arrangement shown in Fig. 74, as a simple contrivance for finding objects on a slide where a more complicated apparatus is not suitable.

A clip of horse-shoe shape attached by two pins, holds the slide upon the stage. The outer sides of both arms are bevelled off and all four sides graduated. When a particular object or part of an object is in the field a line is drawn with a pencil along both sides of each arm crossing the slide. The numbers of the divisions are also marked on the slide with short cross lines, as shown in Fig. 75. If the slide is again brought into its original position, as determined by the

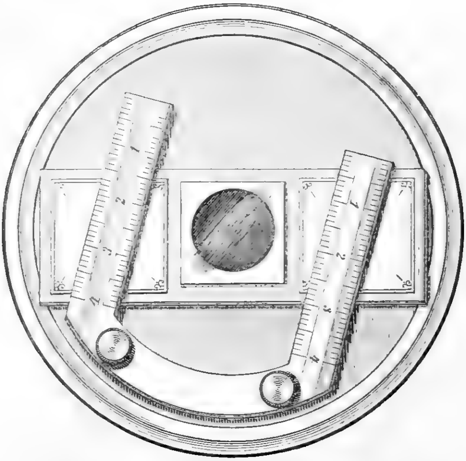
* Amer. Mon. Micr. Journ., iii. (1882) p. 54.

† Mr. J. W. Stephenson informs us that he had a vertical illuminator on this plan constructed in 1879.

‡ Arch. f. Mikr. Anat., xx. (1882) pp. 502–3 (2 figs.).

coincidence of the arms and divisions of the clip with the lines on the slide, the object will necessarily be in the field of view. The

Fig. 74.



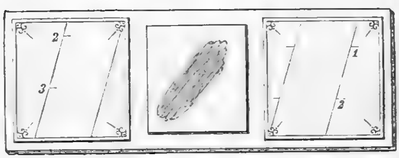


Fig. 75.

arrangement has been found sufficient for an *Hipparchia* scale, with a power of 150.

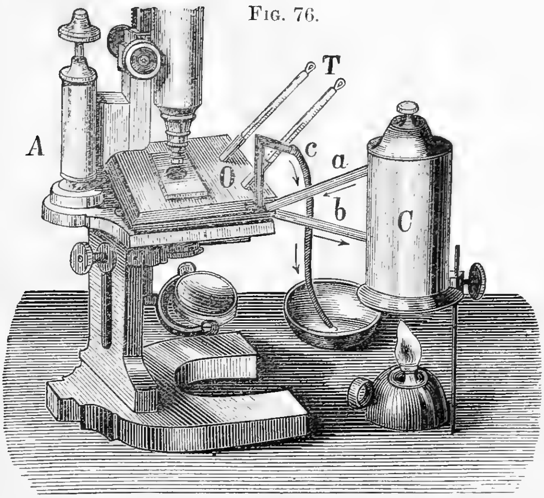
Burnett's Rotating Live-Box.—This is thus described by Mr. R. T. Burnett, its designer:—"The arrangement of this live-box is very simple. Hitherto live-boxes have had the outer cases, which hold the strong or bottom glass, screwed into, or fixed firmly to, the plate that goes upon the stage. This one is constructed so that the outer case fits into a flange or cylinder its own depth. The cylinder is made fast to the plate, leaving the outer case, together with the inner case, free to be rotated at the will of the manipulator, forming, in point of fact, an ordinary live-box resting within a deeply flanged plate.

In using the ordinary live-box, it has hitherto been necessary to take it off the stage whenever the observer has been desirous of turning the object round, or when, in the absence of an 'erector,' it has been necessary to have an object which has been placed head downwards changed to an upright position. This is avoided by the rotating live-box.

Further, in using the ordinary live-box with high objectives, the latter will project within the rim of the live-box; consequently no such change could be made without altering the focus of the Microscope, and causing a loss of time in readjusting the focus and in finding the particular part of the object. By the rotating live-box no alteration of the focus is necessary."

Schklarewski's Hot-water Stage.*—This is represented in Fig. 76. The water, heated by gas or a spirit lamp, passes from the vessel C, through the tube *a*, into the hollow stage O placed on the microscope-stand A. A thermometer T shows the temperature. The

FIG. 76.



water, after passing through the stage and becoming cool, flows back again through *b* into the vessel C, whilst that which is more heated flows through *c*, and the indiarubber tube attached to it, into another receptacle. The stage does not appear to differ essentially from other well-known forms.

Abbe's Condenser.—This apparatus as originally devised † was not easily applicable to any stand but that of Zeiss for which it was specially made. It has now been so modified (Figs. 77 and 78) that it can be applied to the usual substage fitting.

The upper lens A is a thick plano-convex, somewhat larger than a hemisphere. Just below it is a large bi-convex lens serving as a collecting lens to A. The upper focus of the combination is about 2 mm. (in glass) above the plane face of A, that is, about the distance of an object on an ordinary slide. A small metal cap with a central pin-hole can be placed over A for convenience of centering. B is a box-fitting for diaphragms, &c., forming part of the carrier-plate C,

* Thanhoffer's 'Das Mikroskop und seine Anwendung,' 1880, pp. 88–9 (1 fig.).

† Mon. Micr. Journ., xiii. (1875) pp. 77–82 (1 fig.).

made to rotate immediately below and in the axis of the optical combination. The carrier-plate moves laterally by rackwork acted upon by the toothed pinion D. To facilitate changing the diaphragms C can be swung out of the axis on the swivel-joint E, as shown in

Fig. 77.

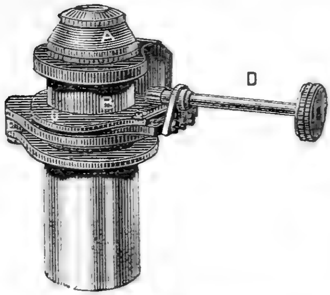


Fig. 78.

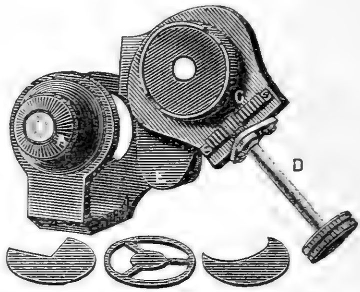


Fig. 78. Circular, lune-shaped, and other diaphragms are supplied, which give a large variety of effects of obliquity both in altitude and in azimuth when used with the lateral and rotating movements of C. For black-ground illumination a central stop is placed in B, and Zeiss supplies special diaphragms to be applied at the back of several of his objectives of large aperture which ensure the dark-ground when used in conjunction with this condenser. With objectives of greater aperture than 1·0 N.A. the condenser must of course be in immersion contact with the base of the slide. The condenser has a numerical aperture of 1·4 nearly.

Bausch and Lomb's Immersion Illuminator.—This illuminator (of which we have no drawing) is intended "to utilize the full capacity of medium and wide angle objectives," up to 152° in crown glass or 1·47 N.A. Its mounting is arranged with an internal diaphragm, which is placed directly under the posterior system of lenses, and entirely contained in the tube comprising the mounting, so as to avoid the projection existing with other condensers, and allows the light to enter only from below. By revolving the milled ring of the mounting, the diaphragm is made to pass laterally from the centre to the extreme edge of the illuminator, thereby projecting a bundle of rays of any obliquity, between 0° (central illumination) and the extreme possible limit 1·47 N.A. When the diaphragm is at its extreme, a second slit, at right angles to it, giving the same volume of light, is opened by the further movement of the milled ring. The makers add that "the fact that it is used with only central illumination of the mirror, will prove especially valuable to those who do not possess instruments with the modern swinging substage and mirror bar."

Bausch's Paraboloid.*—Mr. E. Bausch describes a new form of paraboloid in which the hemispherical hollow in the top is left clear,

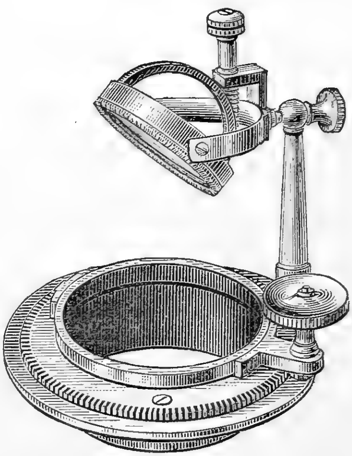
* Proc. Amer. Soc. Micr. 1881, p. 88.

there being a blackened brass cup to fit into it when desired. A hemispherical glass lens fits in the same hollow, "optical contact" being made between the paraboloid and the lens by glycerine and a homogeneous medium. There is also an opening in the side for the admission of light, all other light being stopped out.

The apparatus can thus be used as a Wenham reflex illuminator or an ordinary paraboloid, at the same time providing a hemispherical lens if required.

Browning's Simple Heliostat.—Fig. 79 shows a simple form of heliostat for the Microscope. It is provided with three movements:—(1) The rotation in the vertical plane of the inner cylindrical fitting, carrying the mirror arm, on the fixed toothed disk, by the large milled head; (2) The inclination of the mirror in the double gimbal fitting by means of the endless screw (milled head to the right) acting upon a countersunk worm on the posterior sector forming the inner arc of the gimbal; (3) The rotation of the entire gimbal-mounting of the mirror by the milled head beneath (this movement serving principally for the first adjustment of the mirror to the direction in the horizontal plane in which the reflected beam is to be utilized).

Fig. 79.



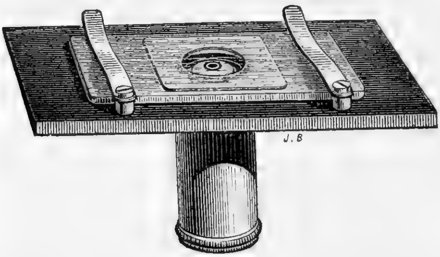
The particular heliostat figured was adapted for mounting in the substage of a Microscope which in that case would have to be inclined so that the optic axis is parallel with the pole of the earth. The mirror being then adjusted to the direction required, the beam of reflected light would be maintained on the same spot by the simple rotation of the mirror arm on the toothed disk, acting as the hour circle of an equatorially mounted telescope, the inner gimbal arc acting as the declination circle.

It can also (and probably better), be mounted vertically upon a separate stand apart from the Microscope, or in a shutter exposed to a southern aspect.

Hayem and Nachet's Modified Hæmatometer.—This is now arranged as shown in Figs. 80–82, and is thus described by M. Nachet:—

"The hæmatometer, formed of a cell with a flat base, devised by Dr. G. Hayem and myself some years ago, has been adopted by the different authors who have experimented on the number of the blood-corpuscles. Some modifications have been made in the apparatus, without changing it essentially, amongst which may be noted the attempt to do away with the eye-piece micrometer ruled in squares. Drs. Thomas and Gowers suggested engraving the lines on the base of the cell itself, an eye-piece micrometer being replaced by an objective micrometer. It is, however, in the first place, nearly impossible to

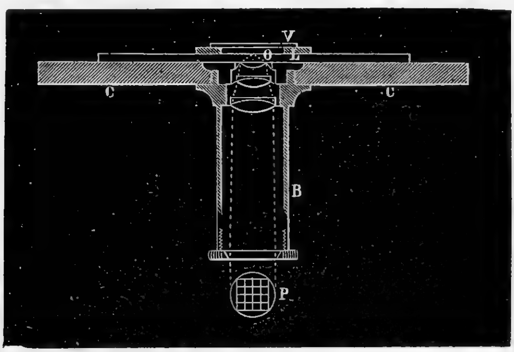
Fig. 80.



engrave lines as fine as are required on such smooth and polished glass as that of which the cell is made, so as to be clearly visible; there is also the risk of breakage, &c., and the inconvenience that when the cell is filled with the liquid, the lines are still fainter and unsuitable for being easily seen.

The new arrangement consists of a metal plate C C, to which a

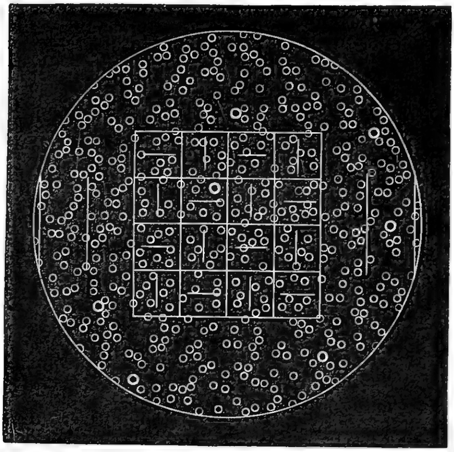
Fig. 81.



tube B, about 20 mm. long, is screwed, containing on its upper part a system of lenses, intended to form a very small image of a set of divisions P in squares, engraved or photographed on glass, and placed at the lower end of the tube. The tube is introduced into the opening of the stage, and on the plate C C is placed the cell of the hæmatometer, containing the liquid with the globules in suspension. These soon fall to the bottom plate of the cell, and the focus of the lenses being exactly upon this plate at O, the image of the squares P is formed there and is visible through the Microscope, at the same time as that of the globules (see Fig. 82).

By this means all the inconveniences attendant upon engraving the divisions at the bottom of the cell are avoided. The divisions may be as exact and as strongly marked as possible, the image

FIG. 82.



depending entirely upon the intensity of the photograph and its size on the reciprocal distance of P and O."

Fasoldt's Test-plate.*—Professor R. Hitchcock does not consider that the diffraction spectra alleged to have been seen by Mr. Fasoldt are any proof of the presence of the separate lines claimed, and "would like Mr. Fasoldt to inform us how fine the individual lines of his wonderful plate are? If the plate has 1,000,000 lines to the inch, the individual lines cannot be broader than half a millionth of an inch. Can such fine lines be ruled? Then it is a question in mechanics, whether a tool can be made so steady that it can draw a line without a tremor of half a millionth of an inch—for if not, then the lines of the plate must run together.

"In regard to the first question, there is already some evidence that Mr. Fasoldt's assumption is not justified. Professor W. A. Rogers ruled a plate with his machine set for 500,000 lines to the inch, making every fifth and tenth line longer than the rest. He then measured the long lines, where they projected from the band, and found that they were so broad, that they overlapped each other, leaving no spaces between them. Evidently, therefore, the band of 500,000 lines did not consist of distinct lines. The spectra were, nevertheless, clear and bright. Hence, we are forced to conclude that the spectra do not prove that Mr. Fasoldt's plate contains 1,000,000 lines to the inch."

We have not seen Mr. Fasoldt's claim as to the diffraction spectra

* Amer. Mon. Micr. Journ., iii. (1882) pp. 52–3.

and do not know how it is worded, but however worded any such claim must originate in a very strange misconception.

The number of lines to an inch capable of being resolved are defined by the equation

$$\delta = \tfrac{1}{2} \frac{\lambda}{n \sin u}.$$

Taking λ for simplicity at $\frac{1}{50000}$ inch (instead of ·5269 μ), and u to be 180° (sin u being = 1), it will be seen that for δ to give 1,000,000 lines to an inch, n—the refractive index of the immersion medium (and with it the objective and the test-plate)—must be made of a substance whose refractive index is 10. What is this wonderful substance—the philosopher's stone of the microscopist?

Or to put the same point in another way:—

The diffraction spectra of lines 145,000 to the inch, can only just be got into the back lens of a homogeneous-immersion objective of 1·50 N.A. To get in the diffraction spectra of 1,000,000 to the inch, the aperture must have been not less than 10 N.A.! How has this aperture been obtained at a time too when we are congratulating ourselves on having reached 1·47 N.A.?

The visibility of the diffraction spectra, so far from proving the existence of lines at the rate of 1,000,000 to an inch, is conclusive proof that they do *not* exist, and that nothing beyond 150,000 at any rate could have been observed.

High Resolving-power.—We have been referred to what is termed a claim of Dr. T. S. Up de Graff to have resolved lines as fine as 152,400 to the inch. Dr. De Graff's statement is, however, simply that he has resolved the last band of Fasoldt's 19-band plate, and he is careful to add "152,400 to an inch, the number of lines *claimed* by the maker to be ruled in this band" (italics in original). While, therefore, fully accepting the observer's statement that the lines which he did resolve were true and not spurious lines, we have, of course, to wait for the demonstration that the maker's claim is correct before commencing again, with clean boards, to endeavour to establish a theory of resolution! The theoretical resolving power of the largest apertured lens yet made (Powell and Lealand's 1·47 N.A.) is about 141,500 lines to an inch.

Binocular Microscopes.*—Professor R. Hitchcock, in discussing the question whether there is any real advantage in binocular over monocular instruments, thinks that the problem is a very difficult one if we attempt to decide on theoretical grounds what effect any particular binocular arrangement will have when applied to the examination of a specified object; to explain how much of the appearance of relief is real, and how much is merely a mental impression produced by the two images in the two eyes.

He, therefore, prefers to confine the discussion to the practical side of the subject. "If the question is whether there is any advantage in a binocular Microscope in studying the form of objects—

* Amer. Mon. Micr. Journ., iii. (1882) pp. 45–8 (8 figs.).

whether the appearance of relief that it gives is necessary to enable us to form a correct idea of the true shape of objects in which the appearance of relief is most striking—the answer must be a decided negative. 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 use only one eye in microscopical work, never make the mistake of supposing that an object is flat merely because it seems to be so. A very short experience enables one to form a perfectly correct idea of the shape of any object by a few turns of the focussing screw. Hence, persons whose means are limited, and who desire to invest a small sum of money in a Microscope to be used for purposes of study, would do well to forego any thought of purchasing binocular stands.

"On the other hand, there are certain qualities of binoculars which commend them to all workers who can afford the additional cost. Apart from any stereoscopic effects it is doubtless true that the use of two eyes whenever possible renders continued observation less tiresome than when only one can be applied to the tube. Some writers have stated that with a monocular one eye is overstrained while the other is not used at all, contending that by using the binocular that trouble is overcome. The two eyes should be used alternately with the monocular, hence they ought to become trained for sharpness of vision, but we doubt if the binocular aids in the way assumed, for we are inclined to believe that although both eyes are simultaneously employed with the binocular, the right eye does most of the real work, the left eye only supplementing its fellow and giving the binocular effect. However this may be, there is a certain ease in working with binoculars which doubtless makes the strain upon the eyes less than with monoculars.

"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."

Mr. G. E. Fell also discusses the binocular Microscope and stereoscopic vision,* and the objections that have been made to such instruments, at the same time describing the Powell and Lealand, Nachet, Wenham, Tolles, H. L. Smith, Abbe, and Barnard forms. He is inclined to believe that a trifling temporary defect in the faculty of consentaneous focalization may be produced by the continued use of one eye with the monocular, so that the microscopist may be really incapacitated for realizing the advantage or effect of stereoscopic vision with the binocular, but he does not agree that the convergence of the tubes produces an unnatural straining of the lateral recti muscles, as the angle of that convergence is about equal to that of the eyes in ordinary observation at 10 to 12 inches.

Professor Hamilton L. Smith† prefers the Nachet binocular, though he considers that the Wenham binocular "is beautifully simple in theory and, except for one thing, perfect in practice. The one great

* Proc. Amer. Soc. Micr., 1881, pp. 69–83 (8 figs.).

† Ibid., pp. 89–91.

fault is it necessitates a very quick convergence of the optical axis. . . . With young eyes and nominally sound this difficulty is not distressing, but for older eyes it becomes annoying. Always upon looking up after using Wenham's binocular, for a while he had found an unpleasant feeling of readjustment of the eyes to the normal condition." He also thinks that "a trained eye would make out about as well and with less trouble the actual structure of any object under examination with the monocular as with the binocular—at least such was his own experience offered with much diffidence. For his own special work with high power and wide angles they are not really suited, but others engaged in another line of investigation requiring only medium power and low angles may find them serviceable."

Electric Light in Microscopy.*—Dr. H. Van Heurck describes his experiments with the electric light, commencing by pointing out that, notwithstanding the perfection of homogeneous-immersion objectives, which show readily delicate details, it frequently happens that the study of diatoms (particularly the small forms) gives considerable trouble, as well by the difficulty of resolving the striæ as by the impossibility of counting them with a low power. It is necessary, therefore, to have recourse to a high power, or even to monochromatic light, which is not always possible, as the sun is frequently hidden, particularly in winter. He has, therefore, for some time thought of the electric light for illumination with the Microscope, and his experiments have demonstrated that the incandescent electric light supplies the illumination *par excellence* which the microscopist requires.

The author then proceeds to treat of the *production* of the electricity, referring to the fact that in a probably near future the inhabitants of large towns will have electricity distributed at their doors, so that the necessities to be met will be principally those of microscopists who live in the country or in small centres. Two modes are at present open for the production of electricity, dynamo-electric machines and batteries. The former are, however, out of the question for the purpose under consideration, a small battery being capable of supplying all that is required at a small expense and little trouble.

As to the different forms of batteries the Bunsen is the most powerful, but the vapours which it gives off, and other points, render it unsuitable for microscopical purposes. In his original paper the author recommended the Tommasi battery, a modification of the former, as in every way preferable and cheaper, giving at the same time a full and detailed description of it, with woodcuts. He has since written us, however, that the battery of E. Regnier is still better and the Tommasi has been discarded. The former is thus described in a supplementary note:—

The Regnier battery has modified Daniell elements with very large surface. They consist of a narrow rectangular cell in copper ($45 \times 23 \times 5\frac{1}{2}$ cm.) within which is a zinc plate, closely enveloped

* Bull. Soc. Belg. Micr., vii. (1882) pp. lxii.–lxxiii. (3 figs.).

in a diaphragm of vegetable parchment, and then sewn up in a linen cloth. The cell is filled with pure water, and 400 grammes of sulphate of copper placed in the upper part. Thus charged, the battery will act during 24 hours, and these may be taken either all together or at different times, the battery losing nothing of its charge when it is not employed. When the battery is discharged (which may be known by the liquid becoming colourless) a third of the liquid is removed by an indiarubber tube and replaced by pure water and a new charge of sulphate of copper as before.

The author then treats of the *storage* of the electricity, and gives a woodcut of an "accumulator" made by E. Regnier on the Planté-Faure system. It consists essentially of two plates of lead, coated with a thick layer of minium, separated, wrapped in flannel, rolled upon themselves, and placed in a glass cylinder, well closed, and containing water acidulated with 10 per cent. of sulphuric acid. On leaving off work in the evening a series of these accumulators can be connected with the battery and left until the following evening, and a sufficient amount of electricity will have been stored up for further use.

The third point dealt with is *lamps*. The arc light is inadmissible, and only the incandescent lamps can properly be used. Those not in a vacuum are very good for photo-micrography, but are too brilliant for ordinary work. Of incandescent lamps in a vacuum or rarefied medium (Swan, Edison, and Maxim) the author prefers those of Swan, which can be worked with a force much less than the Maxim lamps. He obtained from Newcastle some special lamps, eminently suitable for microscopical researches, and now employs those exclusively. They are nearly spherical, and are about 3 cm. in diameter, giving a brilliant light with very little expenditure of force. For obtaining a beautiful white light 5–7 Tommasi elements or 3 or 4 accumulators are sufficient. The 4 accumulators will feed the little lamp for more than 12 hours, and a permanent light could therefore be obtained by putting the battery in operation once or twice a week.

The above details refer, as will be seen, to the Tommasi battery. In the note as to the new battery the author only says "for the little microscope Swan lamps, 5 Regnier elements and an accumulator must be employed."

The *advantages* to be obtained from the employment of the electric light by the microscopist are of two kinds, which the author classifies under the head of "Illumination of the Microscope" and "Photo-micrography." As to the first, he says that "The incandescent electric light surpasses all other illumination. It has the softness of a good petroleum lamp, and shows delicate details nearly as well as monochromatic light. The delicate striæ of *Amphipleura* and the 19th band of Nobert's test are seen with perfect sharpness. Professor Abbe, to whom we communicated the result of our researches, attributes it to two causes, 1st, the much greater whiteness of the light; consequently it contains more blue and violet rays. But, as it has been demonstrated by the measurements made by the Professor with different monochromatic lights, that the resolving-power of an objective of given aperture increases in the same ratio as the wave-length of the light employed diminishes, it follows that the electric light ought to show delicate details more easily than the yellow light of gas or lamps. 2nd. The specific intensity of the electric light being much more considerable than that of other artificial lights, sufficient illumination is obtained with a pencil much narrower than that which must be employed to obtain the same luminous intensity with gas or diffused daylight. Rays much more oblique can therefore be used."

The lamp should be placed in a small box, the cover of which is pierced with an opening. The Microscope is placed on the box, the mirror being turned away from the axis or entirely removed. The light of the lamp is then concentrated by a plano-convex lens and directed into the condenser.

The use of the electric light also allows the microscopist at any moment to photograph an object in the field, and directions are given for proceeding on the dry plate method.

Definition of Natural and Artificial Objects.*—In some "Recollections of my Life," T. Baumann says that the difference between a natural and an artificial object cannot be more briefly or more precisely defined than by saying that under the Microscope the natural object is always more beautiful and the artificial one always more imperfect the more the magnifying power is increased.

Cole's "Studies in Microscopical Science."—Mr. A. C. Cole has projected a weekly periodical under this title "for the use of students, professors and teachers, the medical profession, and others interested in the progress of the natural sciences or engaged in higher education . . . to meet a want, which, even in these days of practical teaching, is felt by every student commencing the study of the natural sciences equally with those who are desirous of devoting their leisure to scientific pursuits.

"It is proposed by means of a carefully prepared and typical object for the Microscope, together with a drawing and descriptive essay, to supply students, microscopists, and members of the medical profession, with a ready means for studying, 1. Microscopical biology in all its branches, 2. The physiological and pathological histology of the body. 3. The essentially modern sciences of microscopical palæontology, mineralogy, and petrology.

"Subscribers will be entitled to receive every week: 1. A microscopical preparation of the highest class and most perfect finish. 2. A printed description of the preparation, in which will be noted: *a.* The literature concerning it. *b.* The habitat, &c. *c.* The methods employed in its preparation as a means of study. *d.* Its principal features, and any necessary additional remarks. 3. A lithographed or engraved drawing, or diagram, of the preparation, in the execution of which the following details will be most carefully considered and adhered to. *a.* Accuracy. *b.* Finish. *c.* Indication of Natural Size, &c.

"The preparations during the first year will consist of a series

* Zeitschr. f. Instrumentenk., ii. (1882) pp. 46-51.

of 26 histological, 18 botanical, and 8 petrological sections issued alternately, and from time to time special subjects will be illustrated by a complete series of preparations with their accompanying drawings and descriptions.

"Announcements will be made for the benefit of special students and practical instruction by this means afforded to those desirous of studying such works as—

Elementary Biology ..	*Huxley and Martin, Parker, &c.*
Practical Histology ..	*Klein, Ranvier, Rutherford, Schäfer, &c.*
Practical Botany ..	*De Bary, Prantl, Sachs, Thomé, Vines, &c.*
Practical Zoology ..	*Claus, Gegenbaur, Huxley, Parker, &c.*
Practical Geology ..	*Geikie, Rosenbusch, Rutley, Zirkel, &c.*

"It is intended that each series when complete shall form a most thoroughly practical work upon the subjects illustrated.

"The letterpress accompanying each series of preparations will afford demonstrations in the special department illustrated, and will thus assist students very materially in their work for university honours, degrees, &c. The drawings and letterpress will be uniform in size, a preface and index will be added, and a suitable case supplied at the end of each year in which the separate numbers can be bound. Small cabinets to contain the preparations, numbered and arranged in such a manner that any object may be readily found on referring to the letterpress (and *vice versâ*) will also be supplied."

The first number, which is before us, deals with yellow fibro-cartilage. After a full description of the specimen, which is a longitudinal vertical section of the pinna of the ear of the cow stained with logwood and eosin, the action of reagents is described. The various methods of preparation which can be adopted for staining and mounting are detailed very fully and completely, and will be found of great practical value. A Bibliography is added in which 37 books and articles are noted. An excellent coloured plate shows the appearance of a section × 333. The second part deals in a similar way with a section of copper beech, stained carmine and iodine green. The plate shows the section × 25.

Mr. Cole's idea appears to us to be an excellent one in every respect, and there is no doubt as to his capability of carrying it out as announced, especially as regards the practical branches of the subject, in which he has acquired a very wide reputation. It only remains for those (and they ought not to be few) who are interested in the success of the scheme to support it.

Journal of the Postal Microscopical Society.—The first number of this quarterly journal has just been issued (56 pp. 9 figs. and 5 plates), containing a considerable amount of useful matter, as will be seen from the following list of contents :—History of the Society; Numerical Aperture; Microscopical examination of Chlorophyll, Inulin, and Protein-crystals; *Tubifex rivulorum*; Diatoms; How to prepare Foraminifera; Lichens. There are notes by Mr. Tuffen West on the slides that have passed through his hands whilst President, and a selection of notes from the Society's note-books, with short notes on preparation and mounting, reviews, apparatus, reports of the Bath Microscopical Society, and Correspondence. If the future numbers of the journal are equal to the first it will be a very useful one, and should be supported by all the members of the Society.

Aperture Diaphragm. [*Ante*, p. 262.]
Journ. Post. Micr. Soc., I. (1882) p. 51 (2 figs.).

AYLWARD'S (H. P.) Working Microscope.
North. Microscopist, II. (1882) pp. 90-1.

BAUMANN, T.—Erinnerungen aus meinem Leben, ein Beitrag zur Geschichte der Präcisionsmechanik. (Recollections from My Life, a Contribution to the History of Precision-mechanics.)
[Includes definition of natural and artificial objects, *supra*, p. 420.]
Zeitschr. f. Instrumentenk., II. (1882) pp. 46-51.

BAUSCH & LOMB Co.'s New Trichinoscope. [*Ante*, p. 258.]
Amer. Natural., XVI. (1882) pp. 429-31 (2 figs.).

BAUSCH'S Homogeneous-Immersion Objectives.
[$\frac{1}{4}$ to $\frac{1}{25}$—140° crown-glass angle—adjustable for water or glycerine immersion.]
Amer. Natural., XVI. (1882) pp. 347.

BLACKHAM, G. E.—Remarks on New Immersion Objectives.
["Do not be troubled or deterred from efforts by 'theoretical limits,' no matter how high the authority that sets them. Newton's dictum as to the impossibility of constructing an achromatic telescope was a stumbling-block in the progress of optical construction and astronomical observation for years, and Mr. Wenham's count of 82° balsam (1·00 N.A.), had it not been disregarded, would have proved an equal barrier in the path of microscopical progress."]
Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 7.

BOLTON, T.—Parkes' Class Microscope. [*Supra*, p. 395.]
Journ. Post. Micr. Soc., I. (1882) pp. 52, 55 (2 figs.).

C., F.—Microscopical Club.
[Reply to H. C. S. as to the formation of such a club.]
Engl. Mech., XXXV. (1882) p. 80.

COX, J. D.—Telescopic Field and Microscopic Aperture.
Amer. Mon. Micr. Journ., III. (1882) pp. 61-9 (3 figs.) p. 76.

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 I. (1881) pp. 303-60.]
Journ. de Microgr., VI. (1882) pp. 143-5, 190-3.

CROULLEBOIS, M.—Théorie élémentaire des Lentilles épaisses. (Elementary Theory of Thick Lenses.)
[Geometrical explanation of Gauss's theory—Compound Microscope, pp. 82-3.] x. & 117 pp. (50 figs.). 8vo, Paris, 1882.

D., E. T.—On Drawing and Painting from the Microscope.
[Neutral tint reflector has often been a snare and delusion to young draughtsmen on account of the reversal of the image, which renders it difficult to fill in the drawing from the Microscope afterwards—prefers the Wollaston.]
Sci.-Gossip, 1882, p. 74.

" " The Microscope and Fine Art.
[General remarks on Microscopical drawing and painting.]
Sci.-Gossip, 1882, pp. 97-8.

DANCER, J. B.—On a Method of Mounting the Limiting Apertures for Increasing the Penetrating Power of Objectives. [*Supra*, p. 407.]
North. Microscopist, II. (1882) p. 92.

DAVIS, G. E.—The Aperture Shutter.
[Further remarks as to the origin of the suggestion.]
North. Microscopist, II. (1882) pp. 88-90 (2 figs.) p. 128.

" " Electric Light for Microscopy.
[Notes as to a trial of the Swan lamp in 1881.]
North. Microscopist, II. (1882) p. 129.

DEBY, J.—Apparatus for obtaining monochromatic light.
[The beam of light from the lamp is condensed by a large bull's-eye, passed through a slit, and refracted by a bisulphide of carbon prism.]

DITTMAR, W.—Mikroskopische Ablesevorrichtung für feine Waagen. (Microscopical reading apparatus for fine balances.)

[Recommends a Microscope for reading off the scale.]

Zeitschr. f. Instrumentenk., II. (1882) pp. 63–4.

"English Mechanic" Microscopical Society.

[Suggestions for working the proposed Society.]

Engl. Mech., XXXV. (1882) p. 195.

ERMENGEM, E. VAN.—The Vertical Illuminator.

[Transl. of paper in 'Bull. Soc. Belg. Micr.,' *ante*, p. 266.]

Amer. Mon. Micr. Journ., III. (1882) pp. 48–9.

FLESCH, M.—Einfache Vorrichtung zum Wiederauffinden wichtiger Stellen in Mikroskopischen Präparaten. (Simple contrivance for finding again important points in microscopical preparations.) [*Supra*, p. 409.]

Arch. f. Mikr. Anat., XX. (1882) pp. 502–3 (1 fig.).

" " Ueber einige Verbesserungen an Seibert und Krafft's Mikroskop-Stativ. (On some improvements in Seibert and Krafft's microscope-stand.)

[The tube, instead of sliding in a socket, moves by a pinion on a brass plate, the edges of which slide in grooves attached to the tube (similar in short to the usual English plan). This allows the tube to be more securely fixed and to be raised higher from the stage when low powers are required. The analyzer and polarizer can also be more readily placed in any given relative position. The tube is blackened inside.]

Arch. f. Mikr. Anat., XX. (1882) pp. 504–5.

HARDY, J. D.—On an improved Compressorium.

Journ. Quek. Micr. Club, I. (1882) pp. 35–6, 51–2 (2 figs.).

HEURCK, H. VAN.—La lumière électrique appliquée aux recherches de la micrographie. (The electric light applied to microscopical researches.)

[*Supra*, p. 418.]

Bull. Soc. Belg. Micr., VII. (1882) pp. lxii.–lxxiii. (3 figs.).

Sep. repr. also with additional note on the new Regnier Battery.

HITCHCOCK, R.—Binocular Microscopes. [*Supra*, p. 416.]

Amer. Mon. Micr. Journ., III. (1882) pp. 45–8 (8 figs.).

" " About Stands.

[Reply to query of the Editors of the 'Botanical Gazette,' (". . . Is it a fact that the extra appliances, &c., are more things of 'fuss and feather' than fruitful additions to biological laboratories?") That some accessories are certainly important, but there is a long list of them which embraces many that are quite useless, and very many others that are mere conveniences. Some few are almost indispensable, and Microscopes should be purchased with substages in every case.]

Amer. Mon. Micr. Journ., III. (1882) p. 54.

" " A New Form of Vertical Illuminator. [*Supra*, p. 409.]

Amer. Mon. Micr. Journ., III. (1882) pp. 54, 78.

" " "The Microscope."

[Further remarks as to Prof. Stowell's Journal.]

Amer. Mon. Micr. Journ., III. (1882) p. 58.

" " The Microscope in Medicine.

[Complaint of the want of interest in practical Microscopy among Physicians.] *Amer. Mon. Micr. Journ.*, III. (1882) pp. 75–6.

" " Ruled Lines as Tests.

["Resolving power alone is not a test to be depended on."]

Amer. Mon. Micr. Journ., III. (1882) pp. 77–8.

HOLMES, E.—What is the meaning of × ?

[Reply to T. R. J. *infra* who "is confusing himself needlessly." "If a drawing of a man 5 feet high be made 20 feet he is × 4 whether the grain of his skin becomes visible or not."]

Sci.-Gossip, 1882, p. 114.

J., T. R.—What is the meaning of the sign × ?

[Points out the error in describing a drawing as × 500 when it is drawn from an object × 50, and the drawing enlarged 10 times—"unless there be detail corresponding with the amplitude the object is not × so many diameters."] *Sci.-Gossip*, 1882, p. 89.

KAIN, —.—Drawing Microscopic Objects.
["Mr. Kain showed (at a meeting of the Camden Society) a method of throwing the image downward by means of a convex mirror, and receiving the magnified image upon a sheet of white paper placed upon the table. It could then be traced without difficulty."]
Amer. Mon. Micr. Journ., III. (1882) p. 59.

KAIN, C. H.—Photo-micrography.
Amer. Mon. Micr. Journ., III. (1882) pp. 71–2, 75.

LOSSNER, O. W.—Telemikroskop (Telemicroscope).
[Abstract of German patent for a combination of a Microscope and a Telescope, D. R. P. 16672, 5th Apr. 1881.]
Zeitschr. f. Instrumentenk., II. (1882) p. 156.

MARTENS, A.—Instrumentenstativ mit Kugelgelenken und Klemmringen. (Microscope-stand with ball joints and fastening rings.)
Zeitschr. f. Instrumentenk., II. (1882) p. 112 (1 fig.).

MATTHIESSEN, L.—Die mittleren Brechungsindices fester und flüssiger Körper im Vergleich mit ihrer Totaldispersion. (The mean refractive indices of solid and fluid substances in comparison with their total dispersions.)
Centr.-Ztg. f. Opt. u. Med., III. (1882) pp. 73–4.

Microscope and Magic-lantern.
[Remarks as to the best objectives by "Sunlight."]
Engl. Mech., XXXV. (1882) p. 202.

MORRISON, —.—Drawing Microscopic Objects.
["Mr. Morrison showed (at a meeting of the Camden Society) an arrangement on the plan of a camera-obscura by which the image was thrown upwards upon a piece of transparent paper placed upon a plate of plain glass."] *Amer. Mon. Micr. Journ.*, III. (1882) p. 59.

Mounting Micro. Lenses.
[Directions by "Prismatique," W. J. Lancaster, and "Micro."]
Engl. Mech., XXXV. (1882) pp. 180, 199, 227.

Objectives and Eye-pieces, best method of determining focal length of.
[Suggestion that Prof. Abbe should give a "short exposition of the subject," with diagrams by Akakia.] *Engl. Mech.*, XXXV. (1882) p. 227.

Objectives, Verification Department for.
[Tabular results of measurements of objectives (*contd.*).]
North. Microscopist, II. (1882) pp. 87, 107, 128–9.

OLLARD, J. A.—Microscopical Drawings.
[Recommends as a simple camera lucida "Forrest's Reflector,"—a thin glass cover adjusted to the eye-piece.] *Sci.-Gossip*, 1882, p. 90.

PINKERNELLE, W.—Apparat zur Erleichterung der mikroskop. Untersuchung von Flüssigkeiten. (Apparatus for facilitating the microscopical investigation of fluids.) *German Patent, No.* 18071, 31*st May*, 1881.

Postal Microscopical Society, History of.
Journ. Post. Micr. Soc., I. (1882) pp. 4–7.

President's Address (*contd.*). *Engl. Mech.*, XXXV. (1882) pp. 213–5.

SCHRÖDER, H.—Ueber Projections-Mikroskope. (On projection Microscopes.)
[Abstr. of original article, *ante*, p. 274.]
Zeitschr. f. Instrumentenk., II. (1882) p. 71 (1 fig.).

VEREKER, J. G. P.—Numerical Aperture.
Journ. Post. Micr. Soc., I. (1882) pp. 7–12 (5 figs.).

WENHAM's Universal Inclining and Rotating Microscope.
This Journal, II. (1882) pp. 255–7 (4 figs. and 1 pl.).
Engl. Mech., XXXV. (1882) pp. 143–5 (5 figs.).
North. Microscopist, II. (1882) pp. 108–10 (1 pl.).
[Remarks by F.R.M.S., supplementing the previous description, and dealing with (1) general design, (2) fine adjustment, (3) stage, (4) diaphragms and substage centering motions.]
Engl. Mech., XXXV. (1882) p. 195.
[Claim by "Another F.R.M.S." that it is the invention of Dr. Edmunds, and replies by F. H. Wenham, Ross and Co., and J. M. Moss; and further remarks by "Another F.R.M.S.," "Yet Another F.R.M.S.," and "Akakia." *Supra*, p. 400.]
Engl. Mech., XXXV. (1882) pp. 217, 237, 260, and 261.

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

Colouring Living Microscopical Organisms.*—A. Certes points out that distilled and ordinary fresh water are toxic to marine Infusoria, and a great number of species which live in water of very different density and chemical composition.

In these special cases the colouring of *living* Infusoria will not succeed, or only very imperfectly, unless care is taken to use a solution of the colouring material prepared with the water which it is desired to examine.

The difficulties attendant upon the above procedure may be avoided by the following process, which has also the advantage that no foreign organisms are introduced. Place on the slide a drop of the *alcoholic solution* (1 : 1000) of the reagent, cyanine, B B B B B violet, gentian violet, dahlia, Bismarck brown, &c. Spread out the liquid with a glass rod and let it evaporate. When the evaporation is complete, or nearly complete, add a drop of the water (fresh or salt) intended to be studied and put on the cover-glass. Almost immediately, if the dose has been well calculated, the phenomena of paralysis and of colouring of the Infusoria may be observed.

In this way the author has coloured several species of *Vorticellæ*, *Paramecia*, *Amœbæ*, *Polytoma uvella* (flagellate) and Bacteria.

Mounting Histological Preparations with Carbolic Acid and Balsam.†—Mr. G. E. Fell transfers the prepared sections from the alcoholic preservative fluid to a clean slip and pours strong carbolic acid over the object immediately, allowing it to run off at one corner of the slide into a suitable receptacle. A thin cover-glass previously prepared with Canada balsam is then quickly applied, the balsam replacing the carbolic acid which, owing to its short contact with the tissue of the preparation, does not produce in it any appreciable shrinkage while still acting as a clearing agent. Pouring the alcohol over the preparation on the slide (followed by the carbolic acid) and allowing it to run off again, removes the extraneous filaments, bits of dust, &c., from about the specimen.

Dr. R. G. Mohr ‡ considers, however, that it is scarcely worth while to experiment with carbolic acid for histological mounts, as Seiler's method of mounting in alcohol balsam is so simple and perfect as to leave nothing more to be desired.

Differentiating Motor and Sensory Nerves.§—By the method adopted by L. Löwe and entitled "Method for obtaining preparations which demonstrate the structural difference between motor and sensory nerves, and are hence adapted for enabling the course of the fibres of the peripheral system of nerves to be traced," a fœtal rabbit, 3 to 4 centimetres in length, taken from the mother during life,

* Sep. repr. Bull. Soc. Zool. France, vi. (1881). See the author's previous papers, *ante*, pp. 279 and 280.

† Proc. Amer. Soc. Micr., 1881, p 87.

‡ Ibid., p. 88.

§ Zool. Anzeiger, iii. (1880) p. 503.

is placed for three months in not less than one litre of saturated solution of bichromate of potash, and the liquid changed twice; the bichromate is then carefully washed out with water, and the specimen finally stained entire in one litre of a weakly ammoniacal solution of carminate of ammonia, and may then be prepared for cutting sections by imbedding in gum-glycerine in the usual way. The motor nerves are darkly stained, and the sensory nerves faintly so.

Preparing Nerve-fibrils of the Brain.* —For making preparations to show the nerve-fibrils of the brain, J. Stilling calls renewed attention to Von Recklinghausen's method of macerating well-hardened specimens in wood-vinegar.

Cochineal Carmine-solution.†—J. Czokor grinds to a fine powder 7 grammes of cochineal (the same amount whatever quality is used) with as much burnt alum, and mixes it with 700 grammes distilled water and boils it down to 400 grammes. After cooling, a trace of carbolic acid solution is added and the whole filtered. From time to time a little carbolic acid solution must be added, and the solution filtered again. It stains substances prepared with alcohol or with chromic acid, the latter rather more slowly than the former. A solution made with a better quality of cochineal stains the nuclei the same colour as hæmatoxylin, the other tissues in various shades of red; if it is prepared with "Blut"-cochineal the intermediate tissue is less deeply coloured, the action resembling that of Grenacher's carmine.

Polarized Light as an Addition to Staining.‡—Mr. A. D. Michael, describing a plan of which he and Dr. J. Matthews are joint authors, suggests that polarized light might be of use as an addition to staining for vegetable and some animal substances, as it seemed to differentiate tissues somewhat in the same way. In practice it might be found to have its disadvantages, but it might have its advantages. No special preparation of the tissues was required, and the conditions were more natural than if they had undergone the process of bleaching and staining. It would also be possible, when they had a known selenite, always to repeat the same effect when required, whereas stained tissues frequently fade, and if there were any doubt as to the meaning of what was seen, the effects could be altered, and results secured that would be unattainable with the fixed effects of double staining. There was, of course, no difficulty in getting triple staining, or producing various colours, but the object which he showed was as if stained with a single colour only. [It was a section of *Serjanus* shown with oblique polarized light on a black ground.] He had heard some discussion as to the best means of obtaining polarized light on a black ground, and had heard it suggested that the results depended entirely on the object, that it was to be obtained only now and then

* Arch. Mikr. Anat., xviii. (1880) p. 468.

† Arch. Mikr. Anat., xviii. (1880) pp. 412–14. Cf. Zool. Jahresber. Neapel for 1880, i. p. 42.

‡ Journ. Quek. Micr. Club, i. (1882) pp. 49–51.

in the case of certain objects which had a capacity for it, also that it depended on the size of the polarizing prism and other causes. No doubt these did affect it to some extent, but he was of opinion that the effect was largely a question of what the object was mounted in. He did not find that Canada balsam was the best medium; in fact, the best effects were obtained by mounting in glycerine, when there was very little difficulty in making out the details, and the object looked brighter upon a blacker ground as contrasted with its appearance when mounted in balsam. He thought the idea would be found worth attention, especially where it was desirable to examine objects under various conditions of direct and oblique light.

Mr. T. C. White, in the discussion which followed, said that he had always found a good deal of difficulty in using polarized light on objects mounted in glycerine; while Dr. Matthews, on the point of the superiority of glycerine over balsam for the kind of examination in question, described his experience as rather the reverse of Mr. Michael's. Whether this arose from any difference in the objects he could not say, but he thought the effect was probably due to some difference in their density; the only way of settling the point would be to mount the same objects in both ways. He also thought that with extremely oblique light, they got fringes of colour—probably owing to diffraction. Mr. Michael had been very successful in getting dark-ground illumination, but there appeared to be some curious effect produced by a spot lens, less colour being produced in that way than without, although it might be supposed that the contrary would be the case. As to the differentiation of tissues, precisely the same effects were obtained as by staining, but with the advantage that a harmonious appearance was always produced, whereas with staining the selective power caused differences of colour which were not always harmonious.

Wickersheimer's Preservative Liquid.*—To the wet and dry methods of preserving with this liquid G. Brösike adds a third, the "damp" method. The subject is injected with the liquid, and the separate parts are moistened with it during dissection, and then enclosed in an air-tight vessel. The method is suited to nerves, tendons, fasciæ, vessels, and ligaments; muscles become bleached under its action. It appears to have no real advantages over a proper treatment with spirit, and the fact of the liquid containing poison must be borne in mind.

Brösike takes this occasion to correct an important printer's error in the official patent.† Instead of 10 grammes of arsenious acid it should be 20 grammes.

Preparing Hæmoglobin Crystals.‡—By using pyrogallic acid, C. Wedl has prepared for studying with the Microscope, spectroscope, and polariscope, hæmoglobin crystals from the blood of man, other mammals, and frogs. The best plan is to remove the colouring

* Centralbl. f. med. Wiss., ii. (1880) pp. 17–19. Cf. Jahresber. Anat. Physiol., ix. (1880) p. 82.

† See this Journal, iii. (1880) pp. 325–6.

‡ Virchow's Archiv, lxxx. (1880) p. 172. Cf. Zool. Jahresber. Neapel for 1880, i. p. 57.

matter from the corpuscles by the action of water, and to place some of the solution of hæmoglobin thus obtained, under a cover-glass (which should be raised at one side by a slip of glass laid beneath it) adding some pyrogallic acid. Frog's blood, the colouring matter of which is very difficult to extract, must remain in a moist chamber for several days before the acid is applied; the crystals then appear within the corpuscles. (Kölliker has seen them similarly in the red corpuscles of *Perca fluviatilis.*) It usually requires several hours' treatment to produce the crystals; they will keep for some time in the fluid.

Preserving Flowers.*—For preserving the colours of parts of flowers which it is desired to mount for the Microscope, Mr. G. Stocker finds a saturated solution of the ordinary potash alum crystallized (Al_2 $3SO_4$, K_2 SO_4, 24 H_2O) most excellent. The objects should remain in the liquid for ten minutes or so, and then be dried between bibulous paper, placed in turpentine to render them transparent, and mounted in balsam. A portion of the vexillum of *Ulex Europæus* so mounted is without any of that reddishness which accompanies specimens mounted in the ordinary way; and a stigma of *Crocus sativus* is as full of colour as in its original state.

Cleaning Diatoms.†—Mr. K. M. Cunningham makes the following suggestion for cleaning diatomaceous material when largely contaminated with sand. "A quantity of the material is placed in a teaspoon, and water is then added until the teaspoon is nearly filled; the spoon is gently shaken with a back and forth or a circular motion, for a few seconds or longer, when the water must be quickly drawn off by applying the tip of a finger to the point of the spoon, taking care to draw off the superficial water, without allowing the heavier sediment to pass over the point. Pour from the spoon into a watch-glass, the surplus water is then drained off, and the diatoms removed for mounting. This method produces a magical concentration of the diatoms, large and small, making the remaining sand inconspicuous by the superabundance of the diatoms."

Gaule's Method of Imbedding.‡—The following method of imbedding was worked out by Dr. J. Gaule, by whom it was communicated to Professor E. A. Birge, who, having tried it on all sorts of tissue, can fully recommend it.

"A piece of tissue of convenient size is to be taken, treated with the ordinary reagents, and stained in the mass. If large it may be convenient to remove it from the staining fluid to alcohol for a few hours and then replace it. When thoroughly stained, the specimen is to be put in 70 per cent. alcohol for about twelve hours, then transferred to absolute alcohol until it is completely dehydrated. Then put it in oil of cloves overnight, or leave it there until it is convenient to imbed it. Place it in turpentine half an hour—large

* Sci.-Gossip, 1882, pp. 65–6.
† Amer. Mon. Micr. Journ., iii. (1882) p. 14.
‡ Ibid., pp. 73–5.

specimens for a longer time—then transfer it to a mixture of turpentine and paraffin, kept melted on a water-bath at about 40° C. In this the specimen, if from liver or intestine, &c., should remain for an hour or more; small nerves and blood-vessels of course need not remain so long. Then transfer it to a bath of pure paraffin, melted at a temperature of 60° C., and leave it for the same length of time. Indeed, if care be taken that the temperature does not materially exceed 60°, the specimen may remain as long as convenient. When the tissue is thoroughly saturated with melted paraffin, a small paper box may be filled with melted paraffin and the specimen placed in it to cool. If properly imbedded, a cut surface has a smooth and shining appearance. No line of division must appear between the specimen and surrounding paraffin. The whole mass should cut, as nearly as possible, like one homogeneous mass of paraffin.

The subsequent handling of the sections varies with their nature. Moderately thick sections of firm tissue may be placed in turpentine to remove the paraffin and mounted as usual in chloroform-balsam. Thin specimens, or those which come to pieces when the paraffin is removed, like thin sections of liver, &c., may be laid on the slide on which they are to be mounted, and the paraffin washed out by benzine, carefully applied by a dropping-tube; allow the benzine to evaporate, then lay on the cover-glass and apply thin chloroform-balsam at the edge of the cover. For exceedingly delicate specimens, such as embryos or osmic acid nerves, another method may be used. Lay the section on the slide, wet with absolute alcohol, and let the alcohol completely evaporate, leaving the specimen attached to the slide; carefully heat until the paraffin is softened or slightly melted. When cool, let a few drops of benzine—best applied with a brush—run over the section until most of the paraffin is gone. When dry, apply the cover-glass and put a thin solution of Canada-balsam in xylol to its edge. The xylol may be used instead of benzine, but it is more expensive.

This method is very convenient, especially for histological laboratories. The specimen once imbedded can be kept for years, and new sections cut as wanted. No change takes place in it, nor can it dry up. It is suited to all tissues. I have imbedded all vertebrate soft tissues, chick and trout embryos, hydras, snails, angle worms, clams, star-fishes, &c., with equal success in every case. The ease with which the sections can be made fully compensates for the time required to imbed. The merest tyro, provided with a good section-cutter, a brush to keep the sections from rolling, and such a specimen, must be a bungler indeed if he cannot cut at least thirty even sections from each millimetre of a moderate-sized specimen such as the œsophagus of a rabbit. With a little practice he should be able to cut a millimetre into one hundred sections without losing more than two. The writer has cut a frog's spinal cord so imbedded into 926 sections $\frac{1}{50}$ mm. thick in one day, and mounted them without losing any sections. No one who practises with these specimens will regard this as much of a feat; it is simply a hard day's work. Specimens as large as the central hemisphere of a rabbit can be stained and imbedded whole.

I append my notes on the spinal cord of a frog, showing the times used in the various processes:—

Cord put into 3 per cent. nitric acid, 2 hours.

Seventy per cent. alcohol, 6 hours.

Stained in hæmatoxylin, 4 hours.

Seventy per cent. alcohol, overnight.

Ninety-five per cent. alcohol, 24 hours.

Oil of cloves, 24 hours (did not wish to imbed till next day); then,

Turpentine, stir half-an-hour.

Turpentine and paraffin, 1 hour.

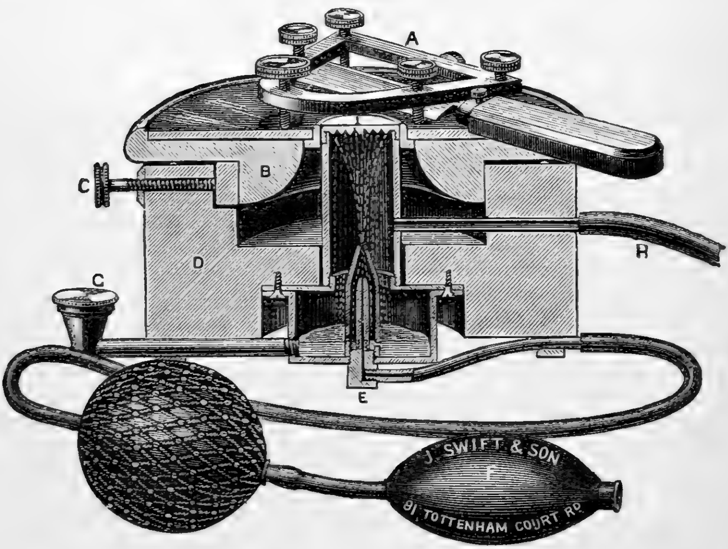
Paraffin, 1 hour.

It should be remembered that these cords imbed easily.

One caution further; select paraffin, if possible, which is bluish-transparent, and which rings slightly when struck. The white opaque sort is by no means as good. Any addition of paraffin-oil, turpentine, &c., to soften the paraffin, renders it granular and brittle, and is decidedly injurious to its cutting qualities."

Williams' Freezing Microtome adapted for Use with Ether.*— The original form of this Microtome was described and figured at pp. 697–9 of vol. i. (1881). It subsequently occurred to Mr. J. W.

FIG. 83.



Groves that it would be an improvement if it were adapted for the use of ether as a freezing agent instead of ice and salt. Mr. J. Swift

* Journ. Quek. Micr. Club, vi. (1881) pp. 293–5 (2 figs.).

accordingly worked out the details of the adaptation which is shown in Fig. 83. D represents the wooden bowl of the original form altered to hold the ether freezing apparatus. A and B are the razor frame and bowl-cover with the glass-plate top upon which the former is moved. The central brass cylinder, instead of being solid, is hollow, so that the ether spray may play up the inside and impinge upon the lower surface of the brass-plate I, upon the upper surface of which the material to be frozen is placed. In the figure, the hollowed cylinder is seen to open below into the ether-containing chamber, into the lower part of which also opens a horizontal tube, which turns up at right angles and ends in a funnel-shaped extremity G, over which screws a cap.

In the centre of the bottom of this chamber is a circular aperture closed by a piece of brass tubing, which passes up vertically to end in a cone with a very small aperture, and having another small hole in it towards the bottom. The lower end of this tube is plugged, and through the plug E passes vertically a very fine tube, which is continuous below with the tube from the apparatus for pumping in air. This consists of an indiarubber pump F, connected by a short piece of tubing with a slightly distensible ball covered with netting, and from the opposite side of which a piece of indiarubber tubing passes on towards E. In the side of the large hollow cylinder of the machine is inserted a small tube connected with a length of pipe H for the escape of the spray after use.

The method of freezing is as follows:—After the material has been partially hardened, and the hardening agent removed, place it on the brass plate I with a little gum mucilage;* then unscrew the cap G, fill the chamber with ether, replace the cap, and commence pumping by pressing the ball F vigorously and rapidly in the palm of the hand. Air will thus be pumped into the net-covered ball, from which it will issue in a continuous jet along the indiarubber tube, up the small tube, through the plug E, and again through the hole at the apex of the conical-ended vertical tube, to pass straight up against the under surface of the plate I. The rush of air thus produced causes pressure on the surface of the ether, and also tends to produce suction at the space between the small central tube and the one which has the conical extremity, so that the ether passes through the hole in the side of the latter tube, rises in the space between the two tubes, and is forced as a jet of spray through the hole in the cone, and so on to the under surface of the plate I. This is roughened in the form of teeth for the purpose of presenting a large area to be acted upon, and also to facilitate drainage. A great deal of the ether drops down into the chamber, and is used again, but a little passes out mingled with the air in such a finely atomized condition that it seems impossible to collect it, and it is therefore conveyed along the tube H to the external air.

The advantages of the new form are that all mess with ice and salt is avoided, that ether can always be kept at hand, and that inhalation of the vapour is limited to the short period during which

* If the material is quite fresh the mucilage may be dispensed with.

the chamber is being filled. The labour of pumping may be reduced by placing the ball-pump between two pieces of wood hinged like lemon-squeezers. Material has been frozen in a room at 96 F. using ether of ·730 sp. gr.

Swift and Son's Improved Microtome.—In the microtome just described the sections are cut and their thickness regulated by the gradual descent of the knife towards the tissue to be operated upon. In order to reverse this process and provide a machine in which the tissue shall ascend towards the knife—as is the case in the ordinary form of section-cutters—Messrs. Swift and Son have brought out their new microtome, a drawing of which is given in Fig. 84, and which

Fig. 84.

is described as follows by Dr. S. Marsh in the new edition of his useful little work on section-cutting.

"The instrument consists of a massive iron upright, terminating at its lower extremity in a clamping arrangement, by which it may be securely fastened to the table. From the top of the upright two highly polished iron bars, lying parallel to each other, run horizontally forwards. These bars correspond to the cutting plate in the usual form of microtome, and upon them, as will be seen at A in the drawing, a flat brass frame carrying a knife is made to glide. The knife is kept firmly in position on this framework by means of the binding screw C, the end of which, terminating in a square clamp, presses against the back of the blade. The face of this clamp is grooved in different directions in such a manner that, according as the back of the blade is received into one or another of these grooves it is pushed from or drawn towards the level of the framework, thus affording a means by which the edge of the knife may be set at varying angles to the tissue to be cut. In front of the iron stand will be seen an angular upright pillar carrying in front of it a short length of sprung brass tube B, into which any of the apparatus presently to be described may be firmly fixed by a clamping screw. By means of a micrometer-screw E fixed at the base of the angular pillar, the sprung tube, and of course whatever it may carry, can be acted upon so as to raise or lower it at pleasure. The amount of movement thus effected is registered by the milled head of the screw, for which purpose three concentric circles have been drawn upon its face, each of which is so graduated that, as the face rotates from mark to mark, the distance traversed by the screw, and which of course determines the thickness of the section, will in the case of the outer circle be 1000th, in that of the middle 500th, and in the inner one 400th of an inch. The index by which these measurements are recorded consists of a spring catch so fitted that, as the milled head rotates, it drops into the divisions of the circles, into either of which it can be shifted at pleasure, or if desired can be thrown out of gear altogether. When it is intended to use the microtome for freezing with ether, the chamber provided for that purpose, and which in the engraving is shown in position, must be employed. This chamber is like the one already described when speaking of the Groves-Williams microtome, and consists of a reservoir for containing the ether and an upright cylinder leading from it, and terminating in a flat plate, upon which the object to be frozen lies. To use the machine, remove the cup D, fill the chamber with ether, then fix the cylinder in the clamp B, when the bellows F being worked the ether will project through the tubes in the interior of the chamber (which were described at p. 431), upon the plate holding the tissue, with the effect of speedily freezing it. When, under the action of the micrometer-screw, the object to be cut has moved upwards between the cutting bars sufficiently high for the purpose, sections are to be obtained by simply pushing the frame carrying the knife obliquely across the bars and through the tissue. For freezing purposes common methylated ether of a density of ·720 answers perfectly well. In winter when ice is plentiful, and where only a very small piece of tissue requires to be frozen, the freezing may be effected without the employment of ether. For this purpose it will be necessary to use Dr. Pritchard's solid freezer, Fig. 85. As will be seen, it consists of a solid metal block, having its upper surface, upon which the tissue to be frozen lies, roughened so as to prevent the specimen from slipping during section. For use, the block and tissue are frozen by being immersed in powdered ice and salt, then the block is secured in the clamp B, and sections cut in the manner just described. The microtome, though essentially a freezing one, may however be employed for cutting objects imbedded in paraffin. For carrying out this, the box shown in Fig. 86 has been provided. The tissue is to be imbedded in this box, and when the paraffin has become quite cold, the box must be secured in the clamp B and the tissue sectionized.

"Yet another piece of apparatus belongs to this machine. It is called an adjustable vice, and is shown in Fig. 87. It is the most useful accessory, and there has long been a want felt for something

Fig. 85.

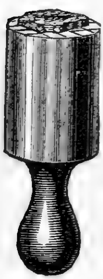
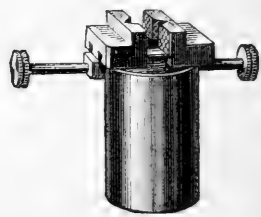


Fig. 86.

Fig. 87.



of its kind. It consists of a cylinder carrying at its upper end the two jaws of a vice. One of the jaws is fixed, whilst the other, being movable, may be made to recede from or approach to its fellow by means of the screw, so that hard substances of different kinds and various sizes may be securely fixed and held between the jaws, when, the cylinder being inserted in the clamp B, sections may be readily obtained. To the really working microscopist, this little appliance will be found of infinite value in a thousand directions. The uses of it are so obvious that no words will be wasted in describing them."

Though in this form, as in the others, the section knife, when in use, is mounted on a frame, no absolute necessity for its adoption exists, for the construction of the microtome permits of the use of an unmounted knife as readily as one mounted on a frame. The frame arranged has some advantages, particularly in retaining the keenness of the blade for a considerable period (coming into contact with nothing but the tissue) and in the confidence which it gives to the inexperienced operator. On the other hand, it renders the disengagement of the sections from the knife both a tedious and unsafe process, and Dr. Marsh is strongly of opinion, as the result of a very considerable amount of practical work, that in the hands of those who by careful practice have taught themselves how to use it, a simple unguarded knife is to be preferred to any mechanical arrangement whatever.

Bausch and Lomb's Standard Self Centering Turntable.—We were unable to give at p. 284 any description of this turntable, but the following has since been supplied by Mr. E. Bausch.

The self-centering arrangement of the turntable is easily manipulated. The jaws are compressed by springs, and bear gently against the slide, so that, although it is firmly held, there is no danger of mutilating its corners or breaking it. One-sixth of a revolution of the milled ring is sufficient to open the jaws to their full extent, and as this is easily done with one hand, the other is free to place the slides. The hand-rest is detachable from the turntable. It has on its lower surface an adjusting screw for varying the distance from the revolving disk.

For refinishing old slides, or others on which the object has not been well centered, a detachable pair of spring clips are provided. Concentric circles up to one inch diameter are turned on the disk.

Crystallised Fruit Salt.*—Mr. G. J. Wightman says that Eno's fruit salt, when crystallised, makes a magnificent polariscope object. The mode of preparation is as follows: In a small test tube, say $3 \times \frac{5}{8}$ inches, dissolve as much of the salt as would rest on a sixpence, by adding distilled water to the depth of an inch. With the end of a glass rod spread a few drops over an ordinary glass slip, and in a few minutes crystallisation will take place. The slide (with selenite) will be seen to be covered with numerous beautiful formations, each somewhat resembling a Maltese cross made up of brilliantly-coloured needle-like crystals. If it is held over the flame of a lamp as soon as the solution is placed on (so as to hasten crystallisation), the colours will be the more splendid without selenite. Other beautiful effects may be produced by the addition of a few drops of alcohol to the test tube. The slides, as soon as dry, may be mounted in Canada balsam.

Allen, F. J.—Cleaning Gizzards.
[Feed the insects on honey, syrup, or treacle, before killing them.]
Journ. Post. Micr. Soc., I. (1882) pp. 48–9.

Arnold, J. W. S.—Microscopical Laboratories.
[Comments, &c., on the previous articles on the same subject—also as to the superiority of small instruments.]
Amer. Mon. Micr. Journ., III. (1882) pp. 69–70, 75.

Basevi, Col.—Mounting Starches.
[Not in balsam, but dry or in glycerine jelly, and viewed as opaque objects.]
Journ. Post. Micr. Soc., I. (1882) pp. 49–50.

Birge, E. A.—On a Convenient Method of Imbedding.
[*Supra*, p. 428.]
Amer. Mon. Micr. Journ., III. (1882) pp. 73–5.

Blood Stains on Steel.
[Dr. M. C. White recognized and measured by means of the vertical illuminator and $\frac{1}{8}$-inch objective, blood-corpuscles upon a steel instrument that had been exposed during two winters in the woods.]
Amer. Natural., XVI. (1882) p. 347.

Bowman, F. H.—See Cotton *infra*.

Chalon, Listes de préparations histologiques et botaniques de M. (List of histological and botanical preparations of M. Chalon.)
Bull. Soc. Belg. Micr., VII. (1882) pp. liv.–vii.

* Sci.-Gossip, 1882, p. 64.

CHEESEMAN, E. L.—Home-made Apparatus for Collecting.
[Bottle-holder to be attached to a stick made of a narrow strip of sheet brass, and an ordinary gimlet-pointed wood-screw with the head flattened.]
Amer. Mon. Micr. Journ., III. (1882) p. 61 (1 fig.).

Coal-sections, Cutting.
[Notes by A. Smith, E. Holmes, and W. D. Smith, on Mr. Kitton's note *infra*—agreeing as to the failure of the carbonate of potash process.]
Sci.-Gossip, 1882, pp. 113–4.

Cotton Fibre, Structure of.
[Review of Dr. F. H. Bowman's book, *ante*, p. 119, with additional remarks.]
Amer. Natural., XVI. (1882) pp. 431–2.

DYCK, F. C. VAN.—Apparent Motions of Objects.
Amer. Mon. Micr. Journ., III. (1882) pp. 72–3.

ELCOCK, C.—How to Prepare Foraminifera.
[For recent Foraminifera *from sand*, such as shore-gatherings, dredgings, &c.—1. Well wash in fresh water to remove the salt. 2. Dry *perfectly*, and allow to get cold. 3. Sift (sieve No. 50 or 60). 4. Float the fine material in cold fresh water. 5. Dry the floatings. Perhaps it may also be found needful to—6. Boil the floatings in *liquor-potassæ*, B. P. 7. *Wash away every trace of potash.* 8. Dry. 9. Re-float in a beaker. 10. Dry again ready for mounting.]
Journ. Post. Micr. Soc., I. (1882) pp. 25–9.

ENOCK, F.—Metal Caps for Glycerine Mounts.
Journ. Quek. Micr. Club, I. (1881) p. 40.

FLEMING, J.—Mounting *Volvox Globator* in Glycerine Jelly.
[After a month's time the *Volvox* mounted in glycerine jelly, boiling, &c. in the usual way, "is perfect in form and colour, and the success of the attempt goes to prove that this Alga can be treated like any other, and may be boiled and pressed without the destruction of its shape."]
North. Microscopist, II. (1882) p. 129.

GOTTSCHAU, —.—Mikrotomklammer für Keil- und plan-parallele Schnitte. (Microtome-clamp for wedge-shaped and plane sections.)
SB. Phys.-Med. Gesell. Würzburg, 1881, pp. 123–5.

GRAFF, T. S. U. DE.—Resolution of Fasoldt's 18-band plate, and last band of 19-band plate.
[*Supra*, p. 416.]
Bausch & Lomb Optical Co.'s Supplement to Catalogue, Feb. 1882, p. 6.

GREEN, J. H.—Cleaning and Mounting Gizzards.
[Kill the insect in spirit and leave for 3 or 4 weeks to harden. On opening the gizzard the loose particles of food or dirt can be washed out by Mr. Nicholson's (*infra*) or other plans.—Mount in slightly acidulated glycerine (not balsam) in a cell of gold-size.]
Journ. Post. Micr. Soc., I. (1882) p. 49.

GROVES, J. W.—Improved Ether Freezing Microtome.
[*Supra*, p. 432.]
Journ. Quek. Micr. Club, I. (1882) pp. 43–4.
Marsh's Microscopical Section-cutting, 2nd ed. 1882, pp. 60–8 (1 fig.).

HATCH, H.—Microscopical Laboratories.
[Remarks on article by Dr. J. W. Crumbaugh, *ante*, p. 287, who, he considers, desires to surround the student with too much and too expensive paraphernalia, discouraging him at the start.]
Amer. Mon. Micr. Journ., III. (1882) pp. 51–2.

HITCHCOCK, R.—Ruled Bands.
[*Supra*, p. 415.]
Amer. Mon. Micr. Journ., III. (1882) pp. 52–3.

" " Illumination and Resolution.
[Directions for resolving *Amphipleura pellucida*—in many cases of failure the fault is entirely in the illumination.]
Amer. Mon. Micr. Journ., III. (1882) pp. 53–4.

HITCHCOCK, R.—Mounting.

[General remarks as to mounting for "busy professional men who value every moment of their time and who, not having learned any simple process for mounting, are discouraged from attempting it by the multiplicity of processes and cements given in the books."]

Amer. Mon. Micr. Journ., III. (1882) pp. 55–6.

" " Collecting.

[Note on objects to be found in March–May, and suggestions for the novice in collecting.]

Amer. Mon. Micr. Journ., III. (1882) p. 77.

JIJEMA, J.—On the Origin and Growth of the Eggs and Egg-strings in *Nephelis*, with some observations on the "Spiral Asters."]

[Contains methods of investigation for (1) genital organs in fresh condition, (2) sections of entire leech, (3) hardening ovaries and egg-strings, (4) section-cutting, (5) surface views of the ovary-wall, (6) examination of early changes in mature eggs.]

Quart. Journ. Micr. Sci., XXII. (1882) pp. 189–211 (4 pls.).

KITTON, F.—Cutting Sections of Coal.

[Describes his failures with the process given under "Coal" in the 'Micrographic Dictionary' (maceration in carbonate of potash), and inquiring for the experience of others.]

Sci.-Gossip, 1882, p. 89.

KORSCHELT, E.—Eine neue Methode zur Conservirung von Infusorien und Amœben. (A New Method for Preserving Infusoria and Amœbæ.)

Zool. Anzeig., V. (1882) pp. 217–9.

KUNZ, —.—Cinnamon Oil for the Examination of Rough Minerals.

[By applying a few drops of oil to the surface of a transparent mineral, the interior can be examined for inclusions, flaws, &c., without grinding the surface flat. Sand can thus be examined for inclusions under the Microscope.]

Amer. Mon. Micr. Journ., III. (1882) p. 59.

LISLE, T.—Glycerine-jelly Mounts.

[Remedy for failures caused by imperfect removal of superfluous jelly :— Apply a mixture of whiting or chalk and water about the consistency of cream, to absorb the jelly ; dry and break off carefully.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

MARCHAL, E.—Préparations microscopiques destinées à l'enseignement. (Microscopical Preparations for Teaching)—*contd.*

[B. Compound Organs, Stems, Roots, Leaves, Flowers ; C. Cryptogams—Ferns, Mosses, Lichens, Algæ, Fungi.]

Bull. Soc. Belg. Micr., VII. (1882) pp. xlvi.–liv.

MARSH, S.—Microscopical Section-cutting. A practical Guide to the preparation and mounting of sections for the Microscope, special prominence being given to the subject of animal sections. 2nd ed. 8vo, London, 1882, xi. and 156 pp. and 17 figs.

MATTHEWS, J.—*See* Michael, A. D.

MICHAEL, A. D., and MATTHEWS, J.—Polarized Light as an addition to Staining for Vegetable and Animal Substances.

[*Supra*, p. 426.]

Journ. Quek. Micr. Club, I. (1882) pp. 49–51.

NICHOLSON, A.—Cleaning Gizzards.

[Open and place in water for a day or two, and clean by agitating the water strongly by blowing through a pipette.]

Journ. Post. Micr. Soc., I. (1882) p. 49.

NOBERT'S Ruling Machine.

[A query as to its construction, &c., by Akakia.]

Engl. Mech., XXXV. (1882) p. 227.

NORDLINGER'S Wood Sections.

[Transverse sections of the most important and most common trees.]

North. Microscopist, II. (1882) p. 130.

OLLARD, J. A.—Micro-Fungi.
[Short note as to mounting.]
Engl. Mech., XXXV. (1882) p. 201.

PFITZNER, W.—Nervenendigungen in Epithel (Nerve-endings in Epithelium).
[Contains description of methods, pp. 731–2.]
Morphol. Jahr., VII. (1882) pp. 726–45 (1 pl.).

Pigeon-post Films.
[Offer of gelatine films used for transmission of news by pigeon post during the siege of Paris.]
Amer. Natural., XVI. (1882) p. 347.

POCKLINGTON, H.—The use of Staining Fluids in Vegetable Microscopy.
[Résumé of various processes.]
Engl. Mech., XXXV. (1882) pp. 210–2.

SCHRÖDER'S Microtome for Cutting Sections of Diatoms, &c.
[A query as to its practical success, by Akakia.]
Engl. Mech., XXXV. (1882) p. 227.

Snow Crystals.
[Query by T. Pearson as to the best way to examine them, "as they melt even in a room where there is no fire.]
Sci.-Gossip, 1882, p. 114.

SORBY, H. C.—Preparation of Transparent Sections of Rocks and Minerals. (*In part.*)
[Account of the method he originally adopted for rock sections when "everything had to be learnt, and there were then none of the facilities you have now."]
North. Microscopist, II. (1882) pp. 101–6.

TEASDALE, W.—G. Chantrill's Method of keeping objects alive for many months.
[A number of zinc shelves kept under a bell-glass, the requisite supply of moisture being provided by a quantity of thick felt kept constantly saturated.]
Journ. Quek. Micr. Club, I. (1882) p. 41.

UNDERHILL, H. M. J.—Cleaning Gizzards.
[Soaking in potash for a day.]
Journ. Post. Micr. Soc., I. (1882) p. 48.

" " —Glycerine-Jelly Mounts.
[Washing superfluous jelly off with a tooth-brush under water is a simpler method than Lisle's (*supra*). Varnish must be applied within half an hour after cleaning or the jelly shrinks from the edge.]
Journ. Post. Micr. Soc., I. (1882) p. 49.

"VOLVOX."—Microscopy.
[Examining circulation of blood in a tadpole's tail. Take a hollow slide, or make a little trough by cementing four little strips of glass on a 3 × 1 slip so as to make a shallow cell. After placing the tadpole on its side in the cell and covering with water, drop a very small quantity of chloroform over its head. There is then "no pain to the tadpole nor risk of bruising it as when it is put under pressure, and should too much chloroform have been given it could not die in an easier way."]
Engl. Mech., XXXV. (1882) pp. 216–7.

WHITE, T. C.—On the Injection of Specimens for Microscopic Examination.
[Describes the process of making transparent injections of a small Mammal with cold injection fluid (Beale's blue fluid), mounting in weak glycerine and camphor-water, and not in balsam or dammar, which would show nothing beyond the injected vessels, all the substructure which bears an intimate relation to the vascular arrangement being obliterated. Criticism of Dr. Carpenter's recommendation of injections by professional mounters.]
Journ. Quek. Micr. Club, I. (1882) pp. 15–9.

WILTON'S (E. W.) Pond Life.
[Intended supply of living objects.]
Sci.-Gossip, 1882, p. 90.

PROCEEDINGS OF THE SOCIETY.

Meeting of 12th April, 1882, 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 8th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Loew, O., and Bokorny, T.—Die Chemische Kraftquelle im lebenden Protoplasma. viii. and 78 pp. (1 plate). 8vo, München, 1882	*Dr. O. Loew.*
Micrographic Dictionary. 4th ed. Parts 8, 9, and 10	*Mr. Van Voorst.*
Postal Microscopical Society—Journal, vol. i. No. 1	*The Society.*

Mr. M. M. Hartog (of Owens College) described some specimens which he exhibited. One of these was a living larva of *Apus cancriformis*, the largest of the water fleas, the specimen shown having been bred this spring from some mud received from Germany. The other exhibits were a series of sections of Entomostraca which had been prepared for histological study. The specimens were killed by adding a few drops of osmic acid to the water in which they were placed, and as soon as they fell to the bottom they were sometimes removed to spirit direct; this plan had its advantage inasmuch as any mutilation was thereby avoided, but on the other hand by opening them in the osmic acid a certain amount of maceration was avoidable, which might in the former case prove to be detrimental to the histological structure. They were first transferred to 30 per cent. spirit, and then to 50 per cent., after which they were placed in cochineal solution in 70 per cent. alcohol and washed repeatedly in clean 70 per cent. alcohol until they gave up no more colour. Afterwards they were placed in 90 per cent., and then in absolute alcohol. They were next treated after Giesbrecht's method, with a greasy medium, and for this purpose whilst they were in the absolute alcohol a small quantity of oil of cloves was poured in, this sank to the bottom of the tube, and the Entomostraca would then lie not at the bottom but just between the alcohol and the oil of cloves, which gradually replaces the alcohol. In this way, with specimens which had been unopened, he had obtained preparations in which there had been absolutely no shrinkage of the protoplasm. Most of the oil of cloves was poured away and the specimens having been imbedded in a mixture of spermaceti and castor oil, the sections were cut in the usual way. It would be noticed that the sections were arranged in series on the slide. By this means of preparation he had been able to make out some important points. The specimens exhibited (sagittal sections) the entire organs of the body, the nervous cord could be well seen, as could also the gullet with its muscles. A rough sketch was made on the slate to illustrate the chief points of interest.

Mr. Beck thought the remarks of Mr. Hartog were exceedingly interesting, for if they were ever really to understand these structures it must be by means of sections. He was glad to have heard the very practical remarks which had been made, and hoped they would be the means of inducing others to practise the process, feeling sure that such a study would elucidate many points which were now involved in mystery.

Mr. Stewart inquired whether in cutting the sections a microtome was used, or whether they were cut by hand. It also occurred to him that this process might be very useful in the preparation of sections of many of the soft-bodied creatures such as the mites or the Arachnida, for it was very difficult to make out many parts of their anatomy by any process of dissection.

Mr. Hartog, in reply, said that in all cases where sections had to be cut in series a microtome was necessarily used in order to secure perfect regularity of thickness. Zeiss's microtome was the one he had employed, using oil to moisten the razor. He agreed that the process would be very useful in the case of mites and spiders, but he thought it well to remark that picric acid—so much in favour for some purposes—should be avoided, as it penetrated too freely and caused the soft tissues to shrink from the chitinous body-wall.

Mr. Crisp called attention to two Microscopes which he had brought for exhibition; one of these, made in Dundee—which it had been proposed to call the "Jumbo" Microscope—stood 4 feet high, with a tube 4 inches in diameter, and weighed about $1\frac{1}{2}$ cwt. It must have been made about 50 years ago. The other (the "Midget") made by Mr. S. Holmes—shown by way of contrast—was completely finished for use, its entire height being only 3 inches, and its weight only a few ounces. Six of such Microscopes could be enclosed in the eye-piece of the larger one. He also exhibited the "Acme" Class Microscope (see p. 251), and Browning's Portable Microscope (see p. 252).

Mr. Beck examined the large instrument and made some remarks as to the peculiarity of its construction.

Dr. Loew's note as to the chemical difference between living and dead protoplasm was read, and a photograph exhibited illustrating his and Bokorny's statement as to the different reaction of dead and living protoplasm on silver salts (see I. (1881) pp. 906–7).

Mr. A. W. Bennett said that the photograph represented two filaments of *Spirogyra nitida*. One of these had been subjected in a living condition to the silver reagent, and the reducing effect of the living protoplasm had converted the cell-contents into a black opaque mass. The other filament had been killed by a 1 per cent. solution of citric acid before treatment with the silver solution. In this case no reduction and consequent blackening is exhibited, the spiral arrangement of the chlorophyll-bands being still perfectly distinct.

Mr. Stewart said he did not see that they had any actual proof that the protoplasm in the one case was dead and in the other living, especially when it was borne in mind that the way in which it was killed was by means of citric acid, a small residual quantity of which he thought might have some effect upon the result.

Mr. Bennett said it was clear that they wanted more particulars before coming to a definite conclusion, though it was naturally to be supposed that all acid had been removed before the tests were applied.

Mr. Hartog referred to the silver staining processes recently described in the Journal.

Mr. Stewart said if they wanted to make silver staining a test in the case of the tissues of living animals it would not always be found an easy thing to do. In cases of operations they could probably get living tissues, but there were many parts which it would be very desirable to test with, which could not be obtained until after twenty-four hours from time of death, and yet he thought that in such cases the outlines of a cell were as perfectly rendered as if they were living. He was afraid that unless the citric acid were entirely eliminated, it would probably exercise an important influence on the results.

Dr. Matthews felt sure that such would be the case, for it was well known that in photography the developing fluids had been acidified—and this especially by citric acid—for the purpose of retarding the reduction of the silver salt, so that the results where acid had been concerned would be very suspicious. The use of alkaline instead of acid preparations was the secret of the modern rapid processes of photographic development.

Mr. Crisp referred to the views of Prof. Grunow on W. Prinz's paper on Diatoms in Thin Rock Sections (see p. 246).

Mr. Ingpen read a note on the use of diaphragms, illustrating his remarks by drawings upon the black-board. The ordinary wheel of diaphragms in general use was, he considered, effective only to a certain extent; and he gave the preference very decidedly to the sliding cylinder-diaphragm so largely adopted on the Continent, which was in fact a modification of that devised many years ago by Varley, in which double cylinders were used, one working within the other. The outer one had a moderate-sized opening sliding up in the substage, or in the ring provided for the purpose beneath the stage, until in contact with the slide. This cylinder was lined with cloth, to facilitate the sliding of the second cylinder, having a similar opening in the cap. By the proper use of this double cylinder the cone of light could be modified in the most perfect manner,—in fact it left nothing to be desired. The plate of diaphragms devised by Dr. Anthony, consisting of a series of apertures in a strip of vellum, to be placed immediately beneath the slide upon the stage, did not appear to him effective, inasmuch as at the position in which it was placed, the cone of rays was far too small to be affected by the size of apertures adopted, passing, in fact, completely within the apertures. He might apply the same remarks to the action of the *calotte* diaphragms, which he regarded as based on a wrong conception of the action of diaphragms. He could not commend the iris diaphragm on the ground that it required a special fitting, and could rarely be used near enough to the slide.

Mr. J. Mayall, jun., said there was another purpose in the application of diaphragms, not touched upon in Mr. Ingpen's remarks, namely, the cutting off different portions of the illuminating pencil. The mere cutting down the diameter was the main object of the wheel of apertures in common use, and of the cylinder diaphragms referred to, but Dr. Anthony's diaphragm was intended to supplement the action of the strictly central aperture by a series that could be easily applied to cut off more or less of the beam after all had been done that was possible in modifying the light with the central apertures,—to use a phrase of Dr. Anthony's, "to give the finishing touch to the illumination." Regarding the *calotte* diaphragm, its application, as a diaphragm alone, immediately beneath the slide, was due to Mr. Zeiss, who was hardly likely to have adopted it unless he had found it effective. The still more recent application of it *above* the condenser must be regarded as a step in advance. Mr. Bulloch, of Chicago, appeared to be one of the earliest to see that the diaphragms *beneath* the optical combination in Gillett's condenser, might be advantageously applied *above* the lenses, where the cone of rays is so short and of such great angular extension that every variation in size or shape in the apertures of the *calotte* would be effective. Mr. Swift had also adopted the *calotte* in connection with the achromatic condenser. The iris diaphragm was effective for low powers, especially when mounted to fit in the stage itself, as adopted by Messrs. Ross; but he had not been satisfied with it in connection with the achromatic condenser. He believed there were difficulties in the construction which rendered it almost impossible to close the aperture with sufficiently accurate centering to be of real service with the condenser. In conclusion, Mr. Mayall said that the great number of devices that had been brought forward in recent years to cut off portions of the illuminating pencil independently of the mere reduction of the cone by strictly central apertures, proved conclusively that a need was felt in that direction.

Mr. Beck said that though there might be differences of opinion as to what was the most valuable kind, he thought no one would dispute the great importance of a good diaphragm, which was of extreme value in rendering visible portions of an object which otherwise could not be seen.

Mr. Ingpen said that his remarks were merely taking things as they stood, and did not, of course, apply to the use of the *calotte* diaphragm with the achromatic condenser. The *calotte* diaphragm, as drawn by Mr. Mayall, was very effective, but almost every effect could be obtained by a very small number of stops with tolerably small apertures. Professor Abbe had satisfied himself of this entirely.

The President read a note on the histology of the Temnopleuridæ, which he illustrated by drawings upon the black-board.

Mr. Stewart called attention to a curious change which took place under certain circumstances in the reticulated network; where there was any friction going on it was found that the interstices became filled up with carbonate of lime, and this seemed to be a case of precisely the same kind as what went on in bone-tissues under similar circumstances. Besides the spicules in the hard tissues there was found a remarkable exception in the structure of the teeth, which more closely resembled silicious rather than calcareous spicules.

Mr. Hartog said that in studying the structure of these organisms it was important to study the soft parts in connection with the hard ones. To do this the specimen should be first stained and then saturated with liquid Canada balsam, which should be evaporated down to a resin: sections could then be cut through the shell and the soft parts, at the same time showing them together *in situ*, and stained as far as they could be.

Mr. Stewart said that in Koch's method it was solid copal varnish which was used instead of solid Canada balsam, the latter being too brittle to enable good sections to be cut. He had seen sections which had been made by this method, and they certainly showed the structure remarkably well in the corals, &c.

The President said that Koch's method was a most excellent one as applied to corals, but it did not answer so well for Echinoderms. He had found it a very good plan to dissolve out the calcareous portions with weak acid. With regard to the fossil forms they all knew that the reticulated structure was entirely lost during fossilization, when it seemed entirely filled up by calcite.

Mr. Stewart remarked that this complex network showed under the polariscope a common axis of tension passing through the entire body.

Professor Abbe's paper "On All-round Vision" was read by Mr. Crisp.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—(1) "Jumbo" Microscope; (2) "Midget" Microscope; (3) "Acme" Class Microscope (see p. 251); (4) Browning's Portable Microscope (see p. 252).

Mr. Hartog:—*Apus cancriformis* and a series of sections of Entomostraca.

Mr. Ingpen:—Zeiss Microscope and sliding cylinder-diaphragms.

Dr. Loew:—Photographs of *Spirogyra nitida*.

Baron Ferd. v. Mueller, K.C.M.G., &c.:—Various dried Algæ from the Phytologic Museum of Melbourne.

Mr. L. A. Sillem:—Foot of Emerald spider.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. John A. Ollard, Henry Palmer, and Henry Pocklington. *Honorary* Fellows:—Professor C. Robin and Dr. L. Dippel.

Conversazione.

The Second Conversazione of the Session was held on the 26th April in the Libraries of King's College, when the following objects, &c., were exhibited:—

Mr. J. Badcock:
Fredericella sultana and *Epistylis* sp.

Mr. C. Baker:
Preparations from the Zoological Station, Naples.

Messrs. R. and J. Beck:
Section of Leech and International Microscope.

Mr. Thos. Bolton:
Fredericella sultana.

Mr. W. G. Cocks:
Lacinularia socialis.

Mr. Crisp:
Various Schizophytes mounted by Dr. Zimmermann, of Chemnitz.

Mr. H. Crouch:
New Portable Microscope, and Siddall's stage for use with ordinary selenites.

Mr. Thos. Curties:
Section of Triton, and larva of *Synapta.*

Mr. E. T. Draper:
Portfolio of drawings of microscopical objects.

Mr. L. Dreyfus:
Argulus foliaceus.

Mr. F. Enock:
Heads of bees showing all the organs of the mouth in their natural form and colour. *Œdipoda cruceata*, one day old; born in England from eggs sent from Troy.

Mr. F. Fitch:
Ventral cords of blow-fly from thoracic ganglion to end of abdomen and ramification.

Mr. C. J. Fox:
Diffraction effects produced by rectilinear and circular gratings.

Dr. H. Gibbes:
Human epididymis with spermatozoa in the tubes; section of mammalian kidney showing ciliated epithelium in the convoluted tubes, and cerebellum injected and treble stained, showing cells of Purkinge and nerves proceeding from them.

Mr. N. E. Green:
Pleurosigma formosum by side and transmitted light, and Nottingham deposit by side light.

Mr. J. Hood:
Cristatella mucedo.

Mr. Joshua:
Ceramium acanthonopum showing tetraspores, and *Hydrurus pencillatus* sent from Norway by Dr. O. Nordstedt.

Mr. A. D. Michael:
Pachygnatha de Geerii showing accessory sexual organs, and *Tenuipalpus spinosus.*

Dr. Millar:
Rectangular network of *Dendispongia Steerii.*

Mr. C. N. Peal:
Experiments illustrating the effect of various kinds of illumination upon the appearances of diatoms. Micro-photographs of diatoms by Mr. J. H. Jennings, of Nottingham.

Mr. B. W. Priest:
Arachnoidiscus japonicus in situ.

Mr. J. W. Reed:
Crystalloids in *Lathræa squamaria* and in the seed of *Ricinus communis.*

Mr. A. Sanders:
Stained sections of the brain of *Hyperopisus dorsalis*, a fish belonging to the family Mormyridæ.

Mr. Sigsworth:
Double platino-cyanide of magnesium and yttrium of various forms.

Mr. L. A. Sillem:
Volkeria pustulosa, plates of star-fish, &c.

Mr. George Smith:
Section of meteorite (U.S.A.).

Mr. James Smith:
Aphides of rose and nettle.

Mr. J. H. Steward:
Pleurosigma angulatum with $\frac{1}{20}$ immersion object-glass by Hensoldt, Meteorite showing fluid cavities, &c.

Mr. A. W. Stokes:
Combustion and volatilization of zinc, copper, iron, &c., in the electric arc under the Microscope.

Mr. H. J. Waddington:
Stephanoceros and *Melicerta.*

Mr. F. H. Ward:
Section of stems of *Jasminium nudiflorum* and *Ampelidea* double stained.

Mr. E. Wheeler:
Ruby and ruby sand section of meteorite showing cavities with liquid or gaseous contents; new Diatomaceæ from Hong Kong, &c.

Mr. T. C. White:
Rectal papillæ of blow-fly and earwig.

Messrs. J. Swift and Son:
Podura scale with student's $\frac{1}{8}$ object-glass on improved American Microscope.

MEETING OF 10TH MAY, 1882, AT KING'S COLLEGE, STRAND, W.C., JAMES GLAISHER, ESQ., F.R.S., IN THE CHAIR.

The Minutes of the Meeting of 12th April 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
Blades, W.—The Enemies of Books. 3rd ed., 1881	*Prof. A. Liversidge, F.R.S.*
Geological and Natural History Survey of Canada. Report of Progress for 1879–80. (8vo, Montreal, 1881)..	*Government of the Dominion.*
Hermann, L.—Handbuch der Physiologie. Vol. iv. Part 2. viii. and 467 pp., 58 figs. (8vo, Leipzig, 1882)	*Mr. Crisp.*
Micrographic Dictionary, Part 11	*Mr. Van Voorst.*

Mr. Crisp read letters from Professor C. Robin and Dr. L. Dippel in acknowledgment of their election as Honorary Fellows.

Mr. Dowdeswell read a paper on "The Bacteria of Davaine's Septicæmia" (see p. 310).

The Chairman said he was very glad that they had had a paper on so important a subject. Observations upon *Bacteria* were daily acquiring more and more value, from their supposed connection with various kinds of disease. He hoped that Mr. Dowdeswell would continue his observations upon the subject, and that he would be able to explain the great discrepancies which he had observed to exist between the size of the specimens he had described and those which had been referred to by other observers.

The Chairman referred to a letter received from Mr. Ralph, the President of the Victoria (Australia) Microscopical Society, in which he mentioned that he expected to be present that evening. At the last moment, however, he had been prevented from coming. He was sure they would all hope that Mr. Ralph would be in England at their next meeting, so that they might welcome him both as one of their ex-officio Fellows and also as the representative of almost the only Colonial Microscopical Society.

Mr. Burnett's note on a new form of rotating live-box was read and the apparatus exhibited (see p. 410).

Mr. Sigsworth exhibited a spring paper-clip which he had found very useful in fastening card cells upon slides and much more convenient for the purpose than the so-called "American" clips.

Dr. Van Heurck's views on the use of the incandescent electric light for microscopy were briefly referred to by Mr. Crisp, who explained, by means of black-board drawings, two cases in which, in consequence of its superior intensity, the electric light might be made use of to extend somewhat the resolving power of an objective. Dr. Van Heurck had recently obtained an improved form of battery which superseded the one he originally described. He found the Swan form of lamp to be the most suitable for microscopical work (see p. 418).

Professor Abbe's paper "On the Relation of Aperture and Power in the Microscope," Part I. (see p. 300), was read by Mr. Crisp, who referred to the complete paper as being one of the most valuable and useful papers that had ever been brought before the Society, dealing as it did not only with the theoretical part of the subject but establishing also a rational standard for the practical construction of objectives.

The Chairman considered that Professor Abbe's paper was indeed a most useful one, and that it would be greatly appreciated by practical opticians.

Mr. Beck said that he considered it was an exceedingly valuable paper, and one that would enlighten a great many persons as to the relative value of aperture and magnifying power in regard to which great confusion had existed. There were people who thought that if they could get a 1-inch objective with an aperture of 120°, they could resolve difficult diatom tests. He had heard it claimed that such glasses had been made, but although he had ordered one he had not yet been able to get it, and hopes that might have been raised by these announcements would be damped by the contents of Professor Abbe's paper. He was very glad that it had been written, because it had been his impression for some time that Professor Abbe had been working exclusively in the direction of wide apertures.

Mr. Ingpen was surprised to hear Professor Abbe, of all persons, charged with an exclusive approval of large apertures, for if any one looked at Zeiss's catalogue, they would see at once that all the dry lenses were of remarkably small angles, nothing exceeding 110°.

Mr. Crisp said that the most opposite notions had been held as to Professor Abbe's views on wide or narrow apertures. Some years ago it was stated, at one of the Society's meetings, that he advocated only narrow apertures, and some correspondence took place in regard to it in the 'Monthly Microscopical Journal.' Again, later, it was insisted that Professor Abbe considered all but wide powers useless to the microscopist! The fact was that Professor Abbe had, since the date of his earliest observations on aperture, advocated the maintenance of a proper ratio between aperture and power—wide apertures for high powers, and small apertures for low powers—and had always insisted on the great importance of perfecting the construction of moderate apertures. The confusion had arisen from the fact of Professor Abbe having shown, in connection with his theory of microscopical vision, that wide apertures, and wide apertures only, gave true images of *minute* objects; but it did not, of course, follow from that, that wide apertures were to be universally used, with low powers and with objects unsuitable, either from their requiring depth of vision or for other reasons.

Mr. J. Mayall, jun., exhibited Ross's "Hospital Microscope," the speciality of which is the fine adjustment, which is of simple construction.

Dr. Maddox read a paper "On Some Micro-organisms from Ice-Water and Hail," illustrated by a number of photo-micrographs.

The Chairman inquired how Dr. Maddox accounted for the existence of the organisms which he had described. Did they come from the atmosphere?

Dr. Maddox thought that with regard to those from the ice of the water-butt, they probably were in the rain-water before it froze, and they alone survived; those found in the water from melted hail most likely came down from the atmosphere with the hail.

Prof. F. J. Bell's paper, "Note on the Spicules found in the Ambulacral Tubes of the regular Echinoidea" (see p. 297), was, owing to the lateness of the hour, taken as read.

The following Instruments, Objects, &c., were exhibited:—

Mr. Burnett:—New form of Rotating Live-Box (see p. 410).
Mr. Dowdeswell:—*Bacteria* illustrating his paper (see p. 310).
Dr. Maddox:—Photo-micrographs illustrating his paper.
Mr. J. Mayall, jun.:—Ross's Hospital Microscope.
Mr. Sigsworth:—Spring clip.

New Fellows.—The following were elected *Ordinary* Fellows:—Messrs. T. S. Up de Graff, M.D., John Inglis, J.P., Captain A. H. Southey, Prof. Ramsay Wright, and John Wright.

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 8 sheets (128 pp.) with Plates and Woodcuts as required. The price to non-Fellows is 4s. 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.

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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.