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., F.L.S.,
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AND

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

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FOR THE YEAR

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CONTENTS.

Muscineæ.

Algæ.

Fungi.

Protophyta

a. Schizophyceæ.

β. Schizomycetes.

MICROSCOPY.

α. Instruments, Accessories, &c.

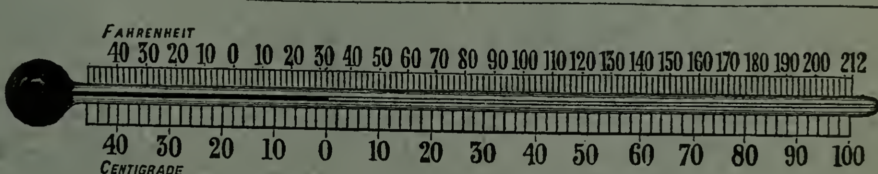
(6) Miscellaneous.

APERTURE TABLE.

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

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

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



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101	3 inches	7	1	10	0	15	24	45	60	75
102	3 inches	12	2	10	0					
103	2 inches	10	1	10	0	22	36	67	90	112
104	2 inches	17	2	10	0					
105	$1\frac{1}{2}$ inch	23	2	10	0	30	48	90	120	150
106	$\frac{2}{3}$ inch	25	2	0	0	70	112	210	280	350
107	$\frac{2}{3}$ inch	32	2	10	0					
108	$\frac{1}{2}$ inch	45	2	10	0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4	0	0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5	0	0	150	240	450	600	750
111	$\frac{1}{4}$ inch	75	3	10	0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4	10	0	250	400	750	1000	1250
113	$\frac{1}{8}$ inch	130	5	0	0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5	5	0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8	0	0	750	1200	2250	3000	3750
116	$\frac{1}{20}$ imm.	180	10	0	0	1000	1600	3000	4000	5000
117	$\frac{1}{40}$ inch	160	20	0	0	2000	3200	6000	8000	10,000

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						No. 1.	No. 2.	No. 3.
		°	£	s.	d.			
150	3 inches	6	1	0	0	12	15	27
151	2 inches	8	1	0	0	18	23	41
152	1 inch	18	1	5	0	46	61	106
153	$\frac{1}{2}$ inch	38	1	5	0	90	116	205
154	$\frac{1}{4}$ inch	80	1	5	0	170	220	415
155	$\frac{1}{6}$ inch	110	2	5	0	250	330	630
156	$\frac{1}{8}$ inch	110	3	10	0	350	450	800
157	$\frac{1}{15}$ imm.	180	6	0	0	654	844	1500

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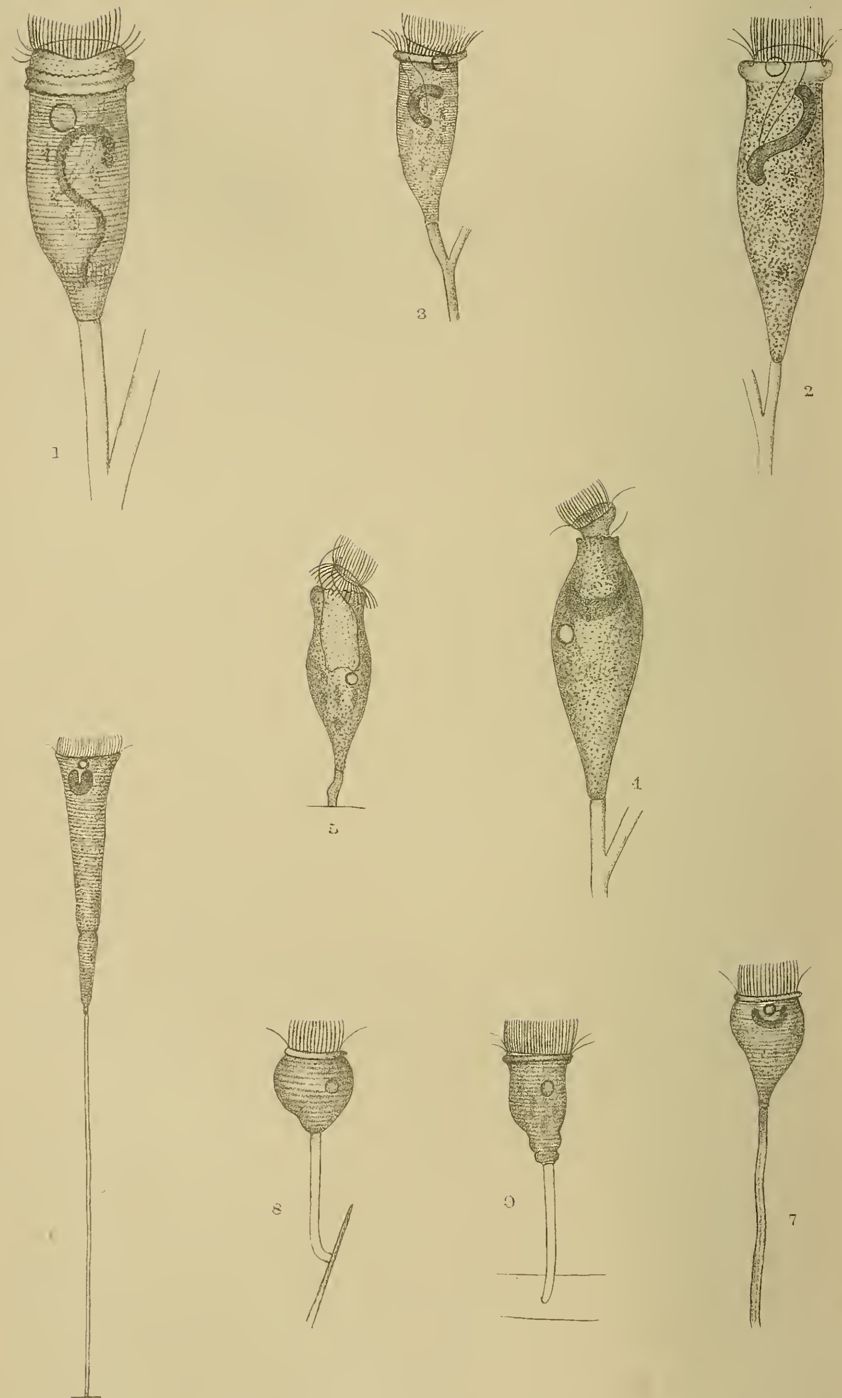


A.C.S. del.

West, Newman lith.

New Peritrichous Infusoria from the United States.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1889.

TRANSACTIONS OF THE SOCIETY.

VII.—*Notices of New Peritrichous Infusoria from the Fresh Waters of the United States.*

By Dr. Alfred C. Stokes.

(*Read* 8*th May*, 1889.)

Plate X.

Epistylis vittata sp. nov., fig. 1.

Bodies elongate-ovate, less than three times as long as broad, widest centrally, tapering posteriorly, slightly constricted beneath the peristome; cuticular surface finely striated transversely, the posterior one-fifth also longitudinally striate; peristome border broad, not everted, not revolute, but when expanded slipping backward and invaginating the anterior border of the body as by a broad, somewhat concave band, both margins of which are usually crenulate; ciliary disc convex, prominent; ciliary circles four; nucleus long, band-like, much curved, often irregularly constricted; pedicle profusely and dichotomously branched, becoming brown with age; ultimate divisions of the foot-stalk about as long as the extended body; zooids many, often one hundred or more in number; contracted bodies obovate, posteriorly annulate in several transverse folds, anteriorly plicate, the contracted ciliary disc frequently conical or snout-like; endoplasm granular, often brownish. Length of bodies 1/120 in.; fully developed colony 1/5 in. in height, conspicuously visible to the naked eye. Hab. Fresh water, attached to the shell of *Physa*.

Epistylis elongata, sp. nov., fig. 2.

Bodies elongate, less than four times as long as broad, widest centrally, tapering thence posteriorly, the sides of the anterior region nearly parallel or slightly tapering; cuticular surface very finely

EXPLANATION OF PLATE X.

Fig. 1.—*Epistylis vittata.*
„ 2.— „ *elongata.*
„ 3.— „ *autumnalis.*
„ 4.— „ *ramosa.*
„ 5.—*Pyxidium nutans.*
Fig. 6.—*Vorticella conosoma.*
„ 7.— „ *Conochili.*
„ 8.—*Opisthostyla globularis.*
„ 9.— „ *similis.*

striate transversely; peristome border thickened, not revolute, when expanded slipping back for a short distance about the anterior extremity of the body, as in *Epistylis vittata*, but not concave; ciliary disc prominent, convex and cushion-like; ciliary circles apparently three; nucleus band-like, much and variously curved in the anterior body-half, often transversely placed; contractile vesicle spherical, situated far forward, apparently in the ciliary disc; endoplasm finely granular; pedicle dichotomously and profusely branched, longitudinally striate, the primary portion about equal in length to an extended body, the ultimate divisions from one-fourth to one-fifth that length; zooids numerous; contracted bodies ovate, often pendent, posteriorly annulate in three or four folds. Length of extended body 1/240 in.; height of entire pedicle 1/56 in. Hab. Pond water; attached to rootlets of *Lemna*.

Epistylis autumnalis, sp. nov., fig. 3.

Bodies conical-campanulate, three times as long as broad, the cuticular surface very finely striate transversely; peristome exceeding the body in width, everted and revolute; ciliary disc obliquely elevated; ciliary circles two, the outer wreath projecting almost horizontally; nucleus band-like, curved, transversely placed in the anterior body-half; contractile vesicle single, spherical, anteriorly located apparently within the ciliary disc; contracted body obovate or subspherical, posteriorly annulate, and invaginating the extremity of the foot-stalk; pedicle dichotomously branched, more or less flexuose, longitudinally striate, the ultimate divisions about one-third as long as the extended zooids, the main stem about one-half the length of the entire pedicle, the whole becoming brown with age. Length of extended body 1/300 in.; height of entire pedicle 1/65 in. Hab. Pond water; attached to the rootlets of *Lemna*, in the autumn.

Epistylis ramosa, sp. nov., fig. 4.

Bodies elongate-ovate or elongate-subvasiform, less than four times as long as broad, widest subcentrally, tapering posteriorly to the pedicle and anteriorly to a short, subcylindrical, neck-like prolongation, the frontal border truncate, crenulate; cuticular surface very finely striate transversely; peristome narrower than the body centre, neither revolute nor much everted; ciliary disc obliquely elevated; ciliary circles apparently two; pharyngeal passage very capacious, extending beyond the centre of the body, its walls conspicuously ciliated; pedicle finely striate longitudinally, profusely and dichotomously branching, the divisions in mature colonies forking from eighteen to twenty times, the ultimate branches about one-half the length of an extended body, the entire foot-stalk becoming brown with age; contracted zooids elongate-obovate, nodding, invaginating the summit of the pedicle and posteriorly annulate, bearing anteriorly a short, longitudinally plicate, snout-like projection, the frontal border crenulate; nucleus band-like, broad, curved, transversely placed in the anterior body-half. Length of body 1/225 in.; colony often measuring 1/15 in. in height. Hab. Pond water, in the autumn.

Pyxidium nutans, sp. nov., fig. 5.

Body elongate-subfusiform, about twice as long as broad, somewhat gibbous, widest centrally, tapering posteriorly to the pedicle, slightly constricted beneath the truncate, finely crenulate peristome border; cuticular surface smooth; ciliary disc conspicuously and obliquely exserted; ciliary circles two, the second wreath extending almost horizontally; vestibulum capacious, extending to near the body centre, strongly ciliate, a long, curved, and conspicuous vestibular bristle present; pedicle short, about one-fifth as long as the body, variously and irregularly undulate; contracted body obovate, suddenly nodding, the posterior region inconspicuously invaginating the anterior termination of the pedicle, and variously and irregularly annulate, with an anterior snout-like projection. Length of body 1/450 in. Hab. Pond water; attached to the rootlets of floating aquatic plants. Solitary.

Vorticella conosoma, sp. nov., fig. 6.

Body conical, soft and flexible, transversely striate, about four times as long as broad, widest at the frontal margin, tapering thence to near the attachment to the pedicle where it is continued as a minute, subcylindrical prolongation, frequently showing at the beginning of the posterior third a slight transverse constriction; peristome border everted, not revolute; cilia short; nucleus transversely placed in the anterior body-half, short, broadly band-like, and much curved, in certain positions of the body apparently ovate; pedicle filiform, from two to three times as long as the body, the muscular thread distinct. Length of body 1/375 in. Hab. Attached to the gelatinous tubules of *Conochilus volvox*.

This interesting form was first observed attached to the same colonies of *Conochilus* which bore the *Vorticella Conochili*, to be next referred to, but in much less abundance, not more than two having been noted on the same cluster of Rotifers. Although the muscular thread is distinctly developed it seems seldom to exercise its contractile power.

The body when contracted becomes elongate-obovate, the transverse constriction appears more distinctly marked, and the region in advance settles back to a slight extent, and inconspicuously invaginates this encircling depression in one or two folds.

Vorticella Conochili, sp. nov., fig. 7.

Body conical-campanulate, soft and changeable in shape, usually somewhat gibbous, one and one-half times as long as broad; transversely striate; peristome slightly narrower than the body centre, the border revolute; ciliary disc somewhat oblique, not elevated; posterior extremity attached to the pedicle through the intermedium of a small button-like projection; pedicle filiform, from seven to eight times as long as the body, only the anterior portion contracting when the foot-stalk is thrown into its small, irregular undulations rather than spiral folds; contracted body obovate, the button-like extremity invaginate within the body; endoplasm colourless; nucleus band-like, much curved, often forming an almost complete circle, situated in the anterior body-half. Length of body 1/750 in. Hab. Attached to the gelatinous tubules of *Conochilus volvox.*

A gathering made in the early part of the month of November contained a large number of the beautiful free-swimming colonial Rotifers *Conochilus volvox*, and every colony of the many examined bore from three to six individuals of this parasite, or perhaps more properly, commensal Vorticella, the pedicle being attached to the gelatinous material which partially inclosed the colony.

Vorticella molesta, sp. nov.

Body conical-campanulate, less than twice as long as broad, soft and changeable in shape, slightly constricted beneath the peristome, the cuticular surface very finely striate transversely; peristome exceeding the body centre in width, revolute; pedicle stout, from five to six times as long as the body, the muscular thread becoming rigid and deeply chestnut brown in colour, presumably with age; contracted body broadly obovate, the extremity of the pedicle invaginate. Length of body, 1/375 in. Hab. Attached to the shell of an aquatic snail, probably a young *Lymnea.* Social.

The muscular thread of some species of *Vorticella*, notably of *V. picta*, has been observed to contain many minute scarlet corpuscles, and similar coloured particles have been noticed within or adherent to the contractile filament of other forms; but in the present species the coloration is a deep chestnut brown extending evenly from the point of attachment to the supporting object nearly up to the posterior extremity of the body, gradually fading until the merest trace is visible at the extreme anterior termination. No pedicle has been seen with the colour reaching entirely up to the posterior border of the zooid. The tint also extends to the sheath, but in a much less marked degree. Those pedicles thus affected had lost most of their contractile power, only the proximal, almost colourless portion retaining its ability to coil, an ability exercised imperfectly and apparently with some difficulty. The remaining or tinted region presents the aspect of a slightly undulate, rigid thread, this extended and stiff condition remaining after the separation of the body and the subsequent death of the muscle. The *Vorticellæ* were infesting the shell of the water snail to such an extent as to impede the progress of the mollusc, and to give it the appearance of being surrounded by a whitish fungoid growth.

The transverse cuticular striæ are very fine, requiring some manipulation of the mirror to display them distinctly.

Opisthostyla globularis, sp. nov., fig. 8.

Body subglobose, soft and somewhat changeable in shape, often slightly gibbous, the length but little greater than the breadth; cuticular surface transversely striate; peristome less than the body centre in width, the border revolute; ciliary disc not elevated; pedicle slightly exceeding the body in length. Length of body 1/000 in. Hab. Pond water, attached to *Hydrodictyon utriculatum*.

Opisthostyla similis, sp. nov., fig. 9.

Body subvasiform, somewhat changeable in shape posteriorly, less than twice as long as broad, somewhat gibbous, slightly constricted beneath the revolute peristome border; the posterior region bearing two rounded, transverse annulations, the anterior being the larger, the posterior extremity often apparently united to the pedicle through the intermedium of a disc-like appendage; cuticular surface strongly striate transversely; ciliary disc slightly and obliquely elevated; pedicle in length somewhat exceeding that of the body, the distal extremity scarcely curved; contracted body obovate, slightly invaginating the extremity of the pedicle. Length of body 1/1125 in. Hab. Pond water, attached to the rootlets of various floating aquatic plants.

This form is readily recognizable from those previously described, by the presence of the annular body-enlargements, and the slight distal curvature of the pedicle. The backward springing of the contracted zooid is that characteristic of the genus, but individuals are at times met with in which the larger, more anterior annulation lacks the usual convex borders, being replaced by flattened, almost perpendicular margins, so that this portion of the body more nearly resembles a short cylindrical constriction. In these individuals the posterior ring is frequently inclosed within that part of the posterior region which invaginates the extremity of the pedicle when the zooid is contracted, the animalcule in these cases appearing not to have extended the body entirely so as to free the pedicle wholly from its invagination, the posterior annulation thus becoming obscure or obsolete.

Halsis (*ἄλσις, leaping*), gen. nov.

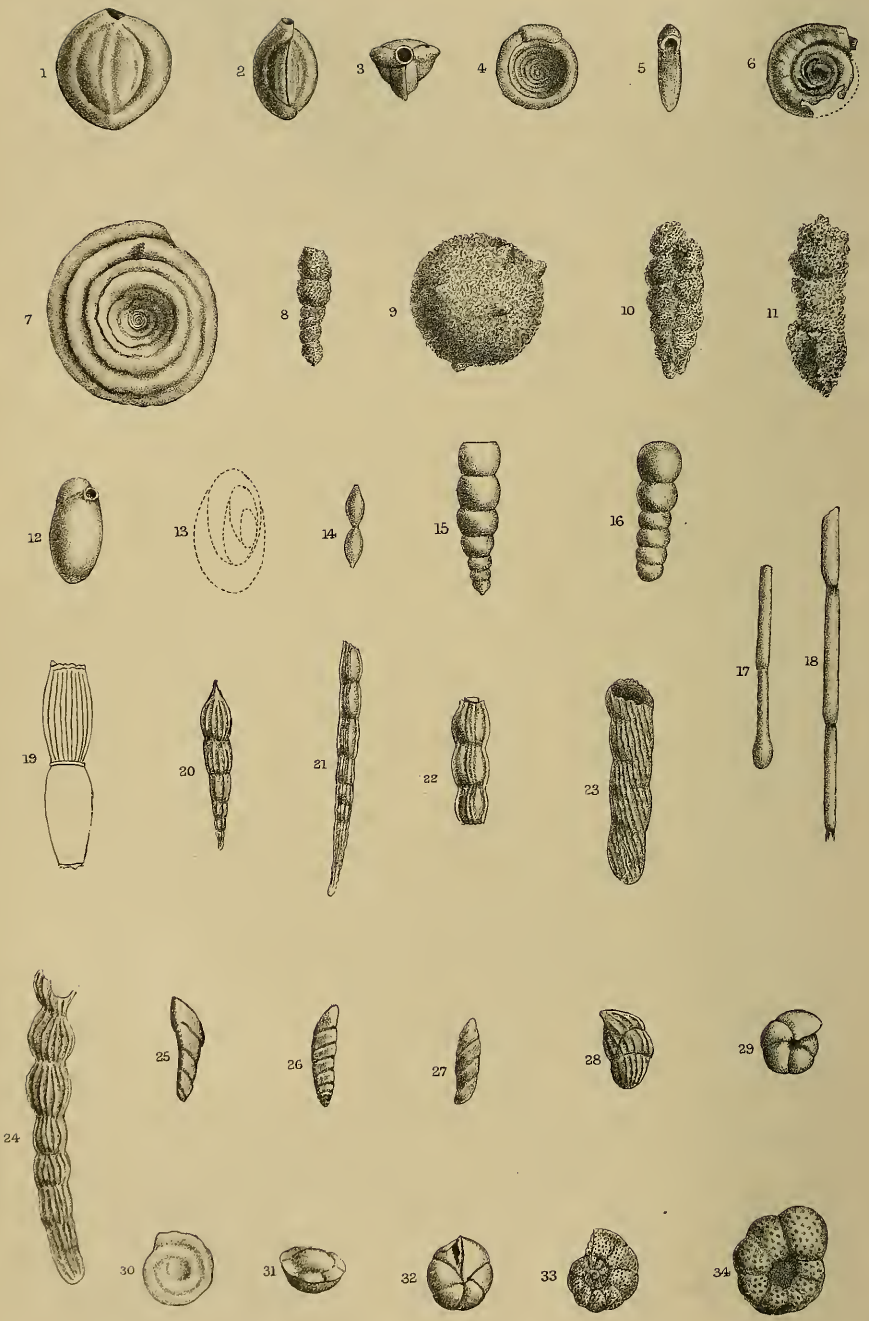
Animalcules free-swimming, ovate, persistent in form, peritrichous; equatorial ciliary girdles two or more; several long, non-vibratile, widely separated setæ projecting from the posterior body region; no supplementary springing hairs; oral aperture terminal, the adoral cilia seeming to form a simple spiral wreath. Inhabiting fresh water.

Halsis furcata, sp. nov.

Body ovate, less than twice as long as broad, the posterior border rounded, the anterior convexly truncate; oral aperture apparently eccentric, surrounded by a short, snout-like projection followed by a short but conspicuous, curved pharyngeal passage; equatorial cilia not numerous, forming three girdles, those of the posterior circlet furcate; caudal hairs long, flexible, distally curved, from six to eight in number, widely separated and arising from the cuticular surface at some distance from the posterior border; contractile vesicle apparently single, spherical, in the anterior body region near one lateral border; nucleus not observed. Movements rotatory on the longitudinal axis, often rapidly backward, with sudden backward leaps. Length of body 1/1125 in. Hab. Standing pond water.

This is undoubtedly a member of the Halteriidæ of Claparède and Lachmann, but it is refused admission to any described genus by the presence of the setose caudal hairs springing from the posterior body region. These are subequal to the body in length, flexible but non-vibratile, trailing behind when the animalcule is swimming. The creature, however, possesses the ability to throw them forward, and it is probable that the sudden backward leaps and quick turns so often made, are accomplished by the action of these posterior setæ. The furcate condition of the cilia composing the posterior equatorial circlet is worthy of notice. The adoral cilia appear to be fimbriated.*

* The original drawing of this animalcule has been mislaid or lost, so that a figure cannot be given.



C.D. Sherborn del.
E.C. Knight, lith.

West, Newman & Co. imp.

Foraminifera from the London Clay.

x 20

VIII.—*Additional Note on the Foraminifera of the London Clay exposed in the Drainage Works, Piccadilly, London, in* 1885.

By C. Davies Sherborn, F.G.S., and Frederick Chapman.

(*Read 8th May*, 1889.)

Plate XI.

In a former paper on this subject, published in the Journal for 1886, eighty-eight well-marked varieties of Foraminifera were described from the London Clay of Piccadilly, London, thus bringing up the total number of forms recorded from the formation to 136. In the present communication we briefly describe twenty-eight forms, twenty-one of which are new to the London Clay. The fact that one of our former "species" required further consideration and examination led us to manipulate the remainder of samples of the clay collected in 1885, and carefully re-examine our earlier washings, in the hope of finding more specimens worth attention. In this we were successful, and are now enabled to amend our views upon the form previously described as *Lagena oviformis*, and also to make some interesting additions to our knowledge of the London Clay foraminiferal fauna. All the specimens here described were obtained from the "black-bed" referred to at p. 740 of our former paper.

EXPLANATION OF PLATE XI.

Fig. 1.—*Miliolina trigonula* (Lamarck).
,, 2, 3. ,, *venusta* (Karrer).
,, 4, 5.—*Cornuspira involvens*, Reuss.
,, 6. ,, *carinata* (Costa),
,, 7.—*Ammodiscus incertus* (d'Orbigny).
,, 8.—*Haplophragmium agglutinans* (d'Orbigny).
,, 9.—*Thurammina papillata* Brady.
,, 10.—*Textularia agglutinans*, var. *porrecta* Brady.
,, 11.—*Clavulina parisiensis* d'Orbigny.
,, 12.—*Chilostomella ovoidea* Reuss.
,, 13. ,, *oviformis* Sherborn and Chapman.
,, 14.—*Nodosaria simplex* Silvestri.
,, 15. ,, *radicula*, var. *annulata* Terq. and Berth.
,, 16. ,, ,, var. *ambigua* Neugeboren.
,, 17, 18. ,, *longiscata* d'Orbigny.
,, 19. ,, sp.
,, 20. ,, *oligotoma* Reuss.
,, 21, 22. ,, *catenulata* Brady.
,, 23. ,, *obliquata* (Batsch).
,, 24.—*Dentalina sulcata* (Nilsson).
,, 25.—*Vaginulina* sp. (? deformed).
,, 26. ,, *legumen* (Linné), var.
,, 27.—*Marginulina attenuata* Neugeboren.
,, 28. ,, *costata* (Batsch).
,, 29.—*Pullenia quinqueloba* (Reuss).
,, 30–32.—*Pulvinulina elegans* (d'Orbigny).
,, 33.—*Discorbina rugosa* (d'Orbigny).
,, 34.—*Anomalina grosserugosa* (Gümbel).

All figures are × 20.

(The specimens will be deposited in the British Museum.)

Miliolina Williamson [1858].

Miliolina trigonula (Lamarck), plate XI. fig. 1. *Miliolites trigonula* Lamarck, Ann. Muséum, v. (1804) p. 351, No. 8; *Triloculina trigonula* (Lam.) d'Orbigny, Ann. Sci. Nat., vii. (1826) p. 229, No. 1, plate xvi. figs. 5–9; Modèle, No. 93.—Common, but very small; the specimen figured is large in comparison with the others found in the Piccadilly Clay. Previously recorded from Sheppey and Haverstock Hill.

Miliolina venusta (Karrer), plate XI. figs. 2, 3. *Quinqueloculina venusta* Karrer, Sitz. k. Ak. Wiss. Wien, lvii. (1868) p. 147, plate ii. fig. 6.—Four individuals. New to the London Clay. Dr. Karrer's specimens came from the Miocene of Kostej.

Cornuspira Schultze [1854].

Cornuspira involvens (Reuss), plate XI. figs. 4, 5. *Operculina involvens* Reuss, Denkschr. k. Ak. Wiss. Wien, i. (1849) p. 370, plate xlv. fig. 20; *Cornuspira involvens* Reuss, Sitz. k. Ak. Wiss. Wien, xlviii. 1863, p. 39, plate i. fig. 2.—One specimen found by Mr. A. M. Davies in a sample of clay given him by one of us. Previously recorded from the London Clay of Sheppey by Mr. Shrubsole.

Cornuspira carinata (Costa), plate XI. fig. 6. *Operculina carinata* Costa, Atti Acc. Pontan., vii. (1856) p. 209, plate xvii. fig. 15 *a*, *b*. —One individual, which, though damaged, still preserves its characters. This specimen almost exactly corresponds to the form figured by Reuss, from the Septarienthon of Offenbach, as *C. Bornemanni*, Sitz. k. Ak. Wiss. Wien, xlviii. 1863, p. 39, plate i. fig. 3, which is the same form as *C. carinata* (Costa). New to the London Clay.

Haplophragmium Reuss [1860].

Haplophragmium agglutinans (d'Orbigny), plate XI. fig. 8. *Spirolina agglutinans* d'Orbigny, Foram. Foss. Vienne, 1846, p. 137, plate vii. figs. 10–12.—One example. New to London Clay.

Thurammina Brady [1879].

Thurammina papillata Brady, plate XI. fig. 9. Brady, Quart. Journ. Micr. Sci., xix. (1879) p. 45, plate v. figs. 4–8.—Not previously recorded from Tertiary beds. Dr. Haeusler * has described numerous varieties from the Jurassic of Switzerland, and Dr. Uhlig † from beds of the same horizon in Austria and Wurtemberg.

Ammodiscus Reuss [1861].

Ammodiscus incertus (d'Orbigny), plate XI. fig. 7. *Operculina incerta* d'Orbigny, Foram. Cuba, 1839, p. 71, pl. vi. figs. 16, 17.—

* Neues Jahrb., 1883 (1), p. 60; Annals Mag. Nat. Hist. 5, xi. 1883, p. 262; Quart. Journ. Geol. Soc., xxxix. 1883, p. 27; Neues Jahrb. BB iv. (1), 1885, p. 30.

† Neues Jahrb., 1882, p. 152.

One specimen. Previously recorded from four localities of the London Clay. (See the former paper, p. 760, *Trochammina.*)

TEXTULARIA Defrance [1824].

Textularia agglutinans d'Orbigny, var., plate XI. fig. 10. D'Orbigny, Foram. Cuba, 1839, p. 136, plate i. figs. 17, 18, 32–34. —This variety of *T. agglutinans*, with its rounded chambers and subcylindrical form, is comparable with Brady's var. *porrecta* (Report, 'Challenger,' 1884, p. 364, plate xliii. fig. 4).

CLAVULINA d'Orbigny [1826].

Clavulina parisiensis, d'Orbigny, plate XI. fig. 11. D'Orbigny, Ann. Sci. Nat., vii. (1826) p. 268, No. 3; Modèle, No. 66.—The specimen mentioned at p. 743 of our former paper is here figured, and is the only example found which shows the characteristic triangular shape of the early chambers. Dr. Brady mentions its occurrence in abundance in the London Clay near Clapham Common.*

CHILOSTOMELLA Reuss [1849].

Chilostomella ovoidea Reuss, plate XI. fig. 12. Reuss, Denkschr. k. Ak. Wiss. Wien, i. (1849) p. 380, plate xlviii. fig. 12 *a–e*.—One specimen. New to the London Clay.

Chilostomella oviformis Sherborn and Chapman, plate XI. fig. 13. *Lagena* (*Obliquina*) *oviformis*, Sherborn and Chapman, Journ. R. Micros. Soc., ser. 2, vi. 1886, p. 745, plate xiv. figs. 19 *a–d*.—The erroneous reference of this form to *Lagena* was principally due to the fact that the interiors of the specimens described were occupied by sand. We have now been so fortunate as to secure a few more specimens which have the internal structure preserved, and we have no hesitation in referring the form to *Chilostomella*. This is also the opinion of Dr. Brady who has kindly examined our specimens. The interest of this form of *Chilostomella* lies in the fact that the successive external chamber envelopes the whole of the previous structure, and thus presents what appears to be a test of a single chamber. We give a dotted outline of the internal structure restored from several partially perfect individuals, and have nothing to add to the original description of the exterior.

NODOSARIA Lamarck [1816].

Nodosaria simplex Silvestri, plate XI. fig. 14. Silvestri, Atti Acc. Gioenia Sci. Nat., vii. (1872) p. 95, plate xi. figs. 268–72.—One small individual. New to the London Clay.

Nodosaria radicula, var. *annulata* Terquem and Berthelin, plate XI. fig. 15. *Glandulina annulata* Terq. & Berth., Mém. Soc. Géol. France, sér. 2, x. (1875) Mém. 3, p. 22, plate i. fig. 25.—One example. New to the London Clay.

* Report 'Challenger,' 1884, p. 395.

Nodosaria radicula, var. *ambigua* Neugeboren, plate XI. fig. 16. *Nodosaria ambigua* Neugeboren, Denkschr. k. Ak. Wiss. Wien, xii. (1856) p. 71, plate i. figs. 13–16.—Two or three examples. Not previously recorded from the London Clay.

Nodosaria longiscata d'Orbigny, plate XI. figs. 17, 18. D'Orbigny, Foram. Foss. Vienne, 1846, p. 32, plate i. figs. 10, 11. *Nodosaria arundinea* Schwager, Sherborn and Chapman, Journ. R. Micros. Soc., ser. 2, vi. (1886) p. 747, plate xiv. figs. 28, 29. *Nodosaria longiscata* d'Orbigny, Brady, Quart. Journ. Geol Soc., xliv. 1888, p. 6.—Since the critical remarks, in our former paper, on d'Orbigny's figures, Dr. Brady has kindly shown us some of the original specimens examined by d'Orbigny, sent to him by Dr. Karrer, of Vienna. We have therefore had the opportunity of verifying Dr. Brady's conclusion that d'Orbigny, although he figured only the "sugar-loaf" form, included the whole of these smooth, slender, reed-like Nodosariæ in one "species." We are much indebted to Dr. Karrer and Dr. Brady for the examination of this form, as the varying conditions of the chambers have unfortunately given rise to almost endless specific naming. Fig. 18 is the particular variety which was named by Terquem *N. sublongiscata* *; it shows four chambers, and is unusually perfect compared with the specimens generally found in the London Clay. Fig. 17 is an interesting example, showing the initial chambers.

Nodosaria sp., plate XI. fig. 19.—The internal cast of two chambers of a Nodosarian, the upper of which shows fine longitudinal striæ.

Nodosaria oligotoma Reuss, plate XI. fig. 20. Reuss, in Geinitz, Palæontographica, xx. part 1 (1872) p. 135, plate xxxiii. fig. 16.—One of the numerous varieties of Linné's *Nodosaria raphanus*, figured by Reuss as *N. oligotoma*. One specimen. New to the London Clay.

Nodosaria catenulata Brady, plate XI. figs. 21, 22. Brady, Report, 'Challenger,' 1884, p. 515, plate lxiii. figs. 32–34.—The two fragments figured are all that were found. New to the London Clay.

Nodosaria obliquata (Batsch), plate XI. fig. 23. *Nautilus obliquatus* Batsch, Sechs Kupfertafeln Conch. Seesandes, 1791, plate ii. figs. 5 *a*, *b*, *c*.—Two fragments only found. New to the London Clay.

Dentalina d'Orbigny [1826].

Dentalina sulcata (Nilsson), plate XI. fig. 24. *Nodosaria sulcata* Nilsson, Petrif. Suecana, pt. 1, 1827, p. 33, plate ix. fig. 19.—Only the fragment figured was found. Not previously recorded from the London Clay.

Vaginulina d'Orbigny [1826].

Vaginulina legumen (Linné), var., plate XI. fig. 26. *Nautilus legumen* Linné, Syst. Nat., ed. 10, 1758, p. 711, No. 248.—This elegant little specimen we regard as a variety of Linné's well-characterized "species."

* Mém. Ac. Imp. Metz, xlii. (1862), p. 437, figs. *a*, *b*, in text.

Vaginulina sp. plate XI. fig. 25.—A small, compressed, and deformed (?) Nodosarian of doubtful relationship.

MARGINULINA d'Orbigny [1826].

Marginulina attenuata Neugeboren, plate XI. fig. 27. Neugeboren, Verh. Mitth. Siebenbürgen Ver. Nat., Jahrg. ii. (1851) p. 121, plate iv. figs. 3–6.—The name *M. attenuata* may reasonably be made to include the whole of the unornamented elongated *Marginulinæ* figured by Neugeboren on his plate iv. Indeed, in his later paper (ibid., Jahrg. xi. 1860, p. 55) he has referred three of his former species (*M. Orbignyana, M. Reussiana,* and *M. irregularis*) to *M. attenuata,* thus showing that he did not then agree with the specific value of gradational varieties. Our specimen is the only one found. Not previously noted from the London Clay.

Marginulina costata (Batsch), plate XI. fig. 28. *Nautilus (Orthoceras) costatus,* Batsch, Sechs Kupfertafeln Conch. Seesandes, 1791, p. 2, plate i. figs. 1 *a–g*.—Only this specimen found. New to the London Clay.

PULLENIA Parker and Jones [1862].

Pullenia quinqueloba (Reuss), plate XI. fig. 29. *Nonionina quinqueloba* Reuss, Zeitschr. Deutsch. Geol. Ges., iii. (1851) p. 47, plate v. figs 31 *a, b*.—Only one specimen of this slightly compressed form has been found; it shows, however, all the characteristics of Reuss's variety. New to the London Clay.

DISCORBINA Parker and Jones [1862].

Discorbina rugosa (d'Orbigny), plate XI. fig. 33. *Rosalina rugosa* d'Orbigny, Foram. Amér. Mérid., 1839, p. 42, plate ii. figs. 12–14.—One specimen, which has lost the final chamber, occurs in the Piccadilly washings. New to the London Clay.

ANOMALINA d'Orbigny [1826].

Anomalina grosserugosa (Gümbel), plate XI. fig. 34. *Truncatulina grosserugosa* Gümbel, Abh. k.-bay. Ak. Wiss., x. (1868) p. 660, plate ii. fig. 104 *a, b*; *Anomalina* sp. Sherborn and Chapman, Journ. R. Micros. Soc., ser. 2, vi. (1886) p. 757, fig. 156.—Having found more specimens of this form, we are able to assign it definitely to Gümbel's "species," according to the suggestion expressed in our former paper.

PULVINULINA Parker and Jones [1862].

Pulvinulina elegans (d'Orbigny), plate XI. figs. 30–32. *Rotalia (Turbinulina) elegans* d'Orbigny, Ann. Sci. Nat., vii. (1826) p. 276, No. 54; *Pulvinulina elegans* (d'Orbigny), Brady, Report 'Challenger,'

ix. (1884) p. 699, plate cv. figs. 3 *a*, *b*, *c*.—Numerous small specimens of this form, which, according to Parker, Jones, and Brady,* passes insensibly into *P. Partschiana* d'Orbigny, occur in our last washings. It has previously been recorded by Professors Rupert Jones and Parker from the London Clay of the bed of the Thames at Chelsea, and from Wimbledon.

* The *Pulvinulina elegans* group, including *P. Partschiana*, were fully treated of by Parker and Jones in 1865. Phil. Trans., clv. pp. 392, 393, 397, pl. xvi. figs. 44–46.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

α. Embryology.†

Uterus and Embryo.‡—Mr. C. S. Minot has investigated the relations of the uterus and embryo in the Rabbit and in Man. In the resting uterus of the rabbit there are six longitudinal folds; the ovum attaches itself on or between the two folds nearest the mesentery, and the placenta is then developed; the two adjacent lateral folds form a cushion ("peri-placenta") about the placenta, but the two folds opposite the mesentery are flattened out by the stretching of the walls to form the swelling to contain the embryo; they constitute the ob-placenta. The entire epithelium lining the uterine swelling degenerates, and this degeneration affects the glands also. The connective tissue increases by hyperplasia in the peri-placenta and to a greater degree in the placenta, and is transformed for the most part into uninucleate perivascular decidual cells, but also in part into large multinucleate cells. In the placental region the glands are preserved as irregular anastomosing rows of coarse granular matter; below the glands is a zone containing wide vessels and large multinucleate cells.

The embryo is attached at first to the surface of the placenta only by the ectoderm, with which the mesoderm soon becomes connected. So soon as the cœlomatic fissure appears we can speak of a fœtal chorion adhering to the placenta. When the allantois grows out it forms the stalk of connection between the embryo and the placental chorion. Outgrowths of the chorion penetrate the glandular layer of the placenta. The cœlom of the embryo does not extend to the edge of the placenta next the peri-placenta, but the mesoderm does and is covered by ectoderm.

In the ob-placenta degeneration and resorption affect only the surface epithelium and the upper part of the glands; the deep portions

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

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

‡ Journal of Morphology, ii. (1889) pp. 341–462 (4 pls.).

remain as a series of shallow cups, having been stretched transversely by the expansion of the ob-placenta. The epithelium of the cups unites into a new continuous layer, the glands grow up into follicles and are again stretched out by the expansion of the walls. The ectoderm which attaches the embryo disappears from the surface of the placenta during the eleventh day; the vascular connective tissue of the allantois probably grows by forming true villi into the placenta, and so comes close to the maternal circulation.

The observations on the human subject are, as may be supposed, somewhat scattered. The author finds that the umbilical cord is not covered by the amnion, but by an extension of the fœtal epidermis. Its cœlomatic cavity is completely obliterated during the third month, and a little later the stalk of the yolk-sac is resorbed. The allantoic epithelium persists as a tube or cord of cells for a long period. The blood-vessels have specialized walls derived from the surrounding mesoderm, but have no true adventitia. Connective-tissue fibres begin to develope during the third month. The amnion is covered by a single layer of ectodermal cells, which are connected by conspicuous intercellular bridges; it has no true stomata. The chorion consists of two layers, mesoderm and ectoderm, both of which are present over all parts of the chorion during the entire period of pregnancy. The mesoderm has at first a dense colourable matrix, with cells, which colour very slightly. During the second month the matrix loses its colouring property, and subsequently the cells acquire a greater affinity for colouring matters. The matrix assumes a fibrous appearance, and in one region the mesoderm is differentiated into an outer fibrillar layer and an inner and thicker stroma-layer. During the first month the ectoderm divides into an outer dense protoplasmic layer and an inner less dense cellular layer. In the later stages of pregnancy the whole ectoderm of the smooth chorion acquires the character of the cellular layer, except near the margin of the placenta. The villi are at first of awkward and irregular form, but their branching gradually becomes more regular, and the twigs acquire a slender and more uniform shape.

The menstruating uterus is characterized by hyperæmia, by hyperplasia of the connective tissue of the mucosa, and by hypertrophy of the uterine glands; the upper fourth of the mucosa is loosened and breaks off, but there are no decidual cells. The changes of the uterus during menstruation and gestation are homologous, the menstrual cycle being prolonged and modified by pregnancy; hence it is that conception takes place only at the menstrual period, for the ovum can only modify the menstrual change, not initiate the formation of a decidua. No satisfactory explanation of the origin of the amnion has yet been offered. The placenta is an organ of the chorion, but we possess no positive information as to how it performs its nutrient functions.

Fecundation and Segmentation of Ova of Rats.*—Professor A. Tafani has observed four stages in the maturation of non-fertilized ova of rats. In some the maturation-spindle extends under the surface, while in others it is directed towards a point of this surface, which it raises up. In some one, and in others two polar globules may be seen to be expelled. Fecundation takes place when the female pronucleus is on the point of being formed. Not more than one spermatozoon

* Arch. Ital. Biol., xi. (1889) pp. 112–7.

has been seen to come into contact with the egg; its head, which is at first homogeneous, soon becomes resolved into a small thread formed of chromatic granules which are connected with one another by filaments, just as in the case of *Ascaris megalocephala*, as described by Van Beneden. The mode of union of the two pronuclei is carefully described. The segmentation-nucleus is comparatively large. The first plane of segmentation passes through one of the meridians of the egg, and the first two blastomeres are exactly equal and similar; it will be remembered that this is not the case in the Rabbit. When there are eight blastomeres they are all equal, but exhibit a tendency to become arranged in two distinct groups. When there are twelve blastomeres four are larger than the rest.

Reproduction and Development of Teleostean Fishes.*—Mr. J. T. Cunningham gives an account of his observations on the ova of Teleostean fishes, made at the new Marine Biological Laboratory at Plymouth. The Common Sole was found to spawn in March, April, and May; the ovum after extrusion is of considerable size, about 1·5 mm. in diameter. It is distinguished by having an immense number of oil-globules of very small size; these are arranged in groups of irregular shape; another characteristic is that the yolk is not perfectly continuous and homogeneous, but coextensive with the blastoderm there is a single superficial layer of separate yolk-masses; this layer extends with the blastoderm, so that when the latter has enveloped the yolk the layer of yolk-segments also envelopes it completely, forming a superficial layer over the whole surface of the yolk. These peculiarities enable the sole's egg to be easily recognized when taken on the open sea in the tow-net. *Mullus* and *Solea* are the only genera whose ova have undoubtedly the peripheral layer of yolk-segments. It is interesting to notice that these ova present a condition of the yolk intermediate between that characteristic of non-pelagic ova and that seen in typical pelagic ova. It is possible that the peculiar character of the ovum of *Solea* indicates that there is no close affinity between this genus and *Pleuronectes*.

After describing a number of ova and his experiments with them, Mr. Cunningham propounds a hypothesis concerning oil-globules in pelagic teleostean ova. He finds that whenever the adult has a large quantity of oil in its tissues, the ova possess one or more oil-globules in the yolk. It is probable that the excess of oil in the tissues of the parents extends into the ovum, and during the development of the latter supplies the embryo with an abundance of fat which is necessary to its constitution. The cause of many ova which are provided with oil-globules having a greater specific gravity than those that are without them must be explained by the greater density of their protoplasm and yolk.

In conclusion, there is a note on the development of the vascular system and cœlom in pelagic ova of Teleostei. In a great many the heart, at the time of hatching, consists of a tube which opens posteriorly out of a wide space between the yolk, while the heart itself is surrounded by another cavity separated from the just mentioned space by a thin membrane; the cavity which communicates with the heart exists, at an earlier stage, as a space between the epiblast of the anterior part of the yolk-sac and the periblast; traced back it is found to be nothing more

* Journal Marine Biol. Assoc., i. (1889) pp. 10–54 (6 pls.).

nor less than the segmentation cavity. The space surrounding the heart is a portion of the true cœlom. The heart is produced by the formation of the central mesoblastic cells into a tube which, as soon as it has a lumen, communicates with the space between the ventral epiblastic body-wall and the periblast. The cavity in which it is contained is due to a splitting of the mesoblast.

The interesting morphological peculiarity about the venous sinus in the Teleostean embryo is that it is the persistent segmentation cavity. This may partially disappear owing to the contact of its walls, but it is not obliterated by the growth of the mesoblast, so that, when the sinus venosus appears, it is not as a cavity or system of veins entirely surrounded by splanchnic mesoblast, but is the old segmentation cavity between the epiblastic ventral wall of the yolk-sac and the periblast. At a later stage, no doubt, the sinus venosus acquires mesoblastic walls all round it, but this is not till the yolk has been absorbed.

β. Histology.*

Vital Processes in Living Cells.†—Prof. C. Frommann has made a study of the vital processes in living cells. He commences with an account of ripe unfertilized and fertilized ova of *Strongylocentrotus lividus*. The granules found in the protoplasm are connected partly by very fine and partly by somewhat coarse and short filaments. The processes between the granules lead to the formation of extremely fine or somewhat coarser plexuses. The radiate marking which is seen in the periphery of some eggs is due partly to rather long fine filaments, which are beset with separate granules or with small spindle-shaped nodules, and partly by somewhat coarser indistinctly granulated cords which are connected by processes with their neighbours; they sometimes take a zigzag course.

All the formed parts of the egg undergo a constant change of form and size as well as some alteration in their refractive power; they fuse with one another or divide into two or more fragments; they disappear, while others are freshly formed; and all these processes occur so rapidly that it is quite impossible to figure all the successive images that are presented. These alterations may, moreover, occur in the most varied manner. Coarser filaments may break up into distinct granules which separate from or unite with one another; others become indistinctly granulated or disappear altogether. These processes are often preceded by a division of the filaments into two or more pieces, which may undergo various kinds of changes. Changes in form may accompany alterations in the characters of the filaments, and they may become bent, hoop-shaped, or united by bonds with their neighbours. Coarser granules exhibit corresponding structures.

The same kind of changes in the yolk-substance are seen in fertilized as well as in unfertilized eggs, and there can be no doubt that, so far as its vital changes are concerned, the yolk-mass completely corresponds to the protoplasm of other cells.

The rounded or oval homogeneous egg-nucleus has a boundary which alters in character; there is often a delicate, pale, and unbroken contour which may yield to one which is delicately granular or

* This section is limited to papers relating to Cells and Fibres.

† Jenaische Zeitschr. f. Naturwiss, xxiii. (1889) pp. 389-412 (1 pl.).

filamentous, and which may project into the nucleus and give its boundaries an irregular appearance. After treatment with 0·2 per cent. chromic acid the nucleus generally retains sharp and refractive contours, while at the same time the nucleolus becomes distinctly apparent.

The much discussed question of the radiate figures in the fertilized egg is next considered. The author does not find that they exhibit the regularity which we should be led to expect from the figures and descriptions of O. Hertwig, Fol, and Flemming; as in the other parts of the cell-body, there are changes in these parts. The rays as well as their constituent parts continually alter their form and character, disappear, and are again built up; these changes are described in some detail.

In embryos with from twelve to sixteen and more cells the spaces between the separate cells are generally very slight; in these granules may be detected, which may possibly be cell-bridges which appear as granules in consequence of their shortness. When the intercellular spaces are somewhat wider there are some indications of filaments.

The changes which take place in the network of the grey substance of the brain of *Torpedo marmorata* and *Raja asterias*, and in the ganglionic cells of the Torpedo, are next considered. The changes which take place in the stroma of the ganglionic cells have the same character as those which occur in the grey substance—and but for their being slower—as what are seen in the eggs of *Strongylocentrotus lividus*. They also correspond in their morphological relations with what has been observed in the blood-corpuscles of Invertebrates, the network of the tentacles of *Hydra*, and the living cartilage-cells of the rabbit. In the leucocytes of the frog not only do the nuclei disappear, and be again formed from protoplasmic parts, but changes may take place in the granular and filamentar parts of the cell-body without any new formation of nuclei. Similar examples may be cited from many plants.

New Formation of Cells.*—Dr. B. Morpurgo finds that new cells are formed by indirect fission, even during acute inanition of the organism. Karyokinetic figures are found both in growing organs and in the adult organs of animals that have died of hunger, and, therefore, in organs where they give signs of a formative process as well as where they represent cellular regeneration. Indirect fission, under whatever conditions produced, becomes less active when there is an inanition of the organism. The numerical diminution of mitoses is relatively less in slightly differentiated glandular cells and in investing epithelia than in highly differentiated glands; of these latter we may say that the process of karyokinesis is almost wholly limited to the period of their more active growth. Of the differentiated organs, the gonads alone exhibited a process of very active karyokinesis during the inanition of the organism. This shows that these organs are highly individualized even in animals which are high in the zoological scale, and that they are able to demand of other organs the sacrifice of a richly nutrient material.

Relation between Cell-body and Nucleus.†—Dr. F. Tangl comes to the conclusion that the sharp boundary between the nucleus and the cell-body disappears when the achromatic nuclear membrane is de-

* Arch. Ital. Biol., xi. (1889) pp. 118–33.
† Math. u. Naturwiss. Bericht. aus Ungarn, vi. (1889) pp. 61–77 (1 pl.).

stroyed, and that it does not reappear until a new membrane is formed around the daughter-figures. During mitosis there is a much closer connection between cell-body and nucleus than when the nuclei are at rest; this is probably due to the intermixture of the nuclear material with the interfilar mass. Particular attention is directed to the influence of preservative reagents on the characters of the cell.

Nerve-cells in Birds.*—Sig. E. Falzacappa has investigated the origin of the nerve-cells and the minute structure of the central nervous system in birds. His observations led him to the following conclusions:—(1) there is in the embryonic state an entire absence of the polygonal nerve-cells, but the primordial cells are identical with those of the neuroglia of the adult; (2) cells arise from the primitive elements by gemmation, after the fashion of a *Nostoc* chain; (3) these new cells are gradually transformed into the free polygonal elements; (4) the nuclei of the primordial cells resemble those of the adult neuroglia; (5) the primitive cells furthermore respond to reagents in the same way as the neuroglia or the perfect polygonal cells. The primordial cells of the embryonic brain are therefore neurogenetic, giving rise to the special nerve-cells. The author proceeds to bring forward detailed histological evidence in support of the conclusion that the specific nerve-cells have the same nature as those of the neuroglia. Plates are promised in a completed memoir.

Form and Size of Red Blood-corpuscles of Adult and Larval Lampreys.†—Mr. S. H. Gage has examined the red blood-corpuscles of the lampreys of Cayuga Lake. The varying statements made with regard to these cells give an interest to his observations. Wagner, in 1838, described the circular outline of these cells, and he, with Kölliker and others, have noted their biconcave character. Gulliver and Günther state that they are flat or biconvex, and neither Gegenbaur nor Wiedersheim draw attention to their peculiarities; Shipley and Thompson have asserted that the blood-corpuscles of the larvæ were oval and of the adult circular. Mr. Gage finds that the red blood-corpuscles of both adult and larval lampreys are circular, biconcave, nucleated discs; the observation that they run into rouleaux, like those of all Mammals, except the Camelidæ, appears to be new.

γ. General.

Fresh-water Fauna of East Africa.‡—Dr. F. Stuhlmann has a preliminary report on his investigation of the fresh-water fauna of East Africa. The Ostracoda are well represented, both by species and individuals, and there appear to be some very remarkable forms among them. The Oligochæta—*Perionyx*, *Eudrilus*, and *Digaster*—are very numerous; there are several species of *Nais*, and a large number of *Dero;* a new species of *Æolosoma* was found in enormous quantities. Turbellarians appear to be scarce. Of Nematodes some small forms of *Rhabditis* are reported. *Conochilus volvox* is very common. A small clear greyish-green *Hydra* with five arms was observed. The Protozoa are very numerous, there being quite a series of Rhizopods, several species of *Vorticella*, &c., and a number of Flagellata.

* Bull. Soc. Nat. Napoli, ii. (1888) pp. 185-93.
† Proc. Amer. Soc. Micr., x. (1888) pp. 77-83.
‡ SB. K. Akad. Wiss. Berlin, 1888, pp. 1255-69.

B. INVERTEBRATA.

Lymphatic Glands of Cephalopods and Decapodous Crustacea.*—M. L. Cuénot considers that the organ in Cephalopods which Férussac and d'Orbigny regarded as the pellicular appendage of the auricle, and Owen as the homologue of the second branchial heart of *Nautilus*, is a lymphatic gland. He describes it as being bounded externally by a thick epithelial layer; its cavity is traversed by a complicated network of connective tissue, in the meshes of which there are a number of nuclei and of cells which exhibit the peculiar mode of development of lymphatic cells; that is to say, whose nuclei become gradually surrounded by refractive granules, which form the characteristic and constant contents of amœbocytes. In the decapodous Crustacea there are two sets of lymphatic glands; the first and most important (and, above all, the most constant) is situated in the gill between the efferent and afferent vessel; the other may be seen in a Crab by carefully raising the dorsal carapace and removing the cuticular matrix; to the latter it adheres strongly. It begins a little below the heart on either side of the middle line and terminates at the level of the last pair of thoracic appendages; each of these glands has the form of an elongated pouch, which is slightly contractile and communicates freely with subjacent venous lacunæ. In section it is seen to be bounded externally by the chitinogenous matrix; there then comes a zone of irregularly disposed muscular fibres, and then a network of connective fibres, in the cavities of which there are a number of nuclei and cells. The contents of a living gland were found to consist of a considerable number of mature amœbocytes, filled with refractive granules and developing nuclei, mixed with numerous reserve-products. In the Brachyura these organs appear to be easily seen; among the Macroura they have been found active in *Pagurus striatus* and *Eupagurus Prideauxi*, but greatly reduced in *Galathea strigosa* and the Spiny Lobster.

Mollusca.

α. Cephalopoda.

Structure of Siphon and Funnel of Nautilus Pompilius.†—Mr. H. Brooks has some preliminary remarks on this subject. The siphon commences in the first chamber as a cæcum, the closed end resting against the inner surface of the apex of the shell; it consists of a series of tubular sections extending from septum to septum, and increasing in diameter as the chambers expand. Each section is made up of an outer calcareous sheath, and an inner tube of conchiolin. In the outer sheath there are spicules which overlie one another, and are arranged in such a way as to form an exceedingly porous structure; the spicules are fusiform, and are, as a rule, arranged in stellate figures; those that extend beyond the outer surface of the sheaths often end in irregular knobs, many of which have the appearance of chestnut burrs. In very young siphons, the sheaths are made up of slender threads, placed in the same way as the spicules of the older sheaths. The spicules are made up of slender transparent sticks of calcareous matter, which are held together in bundles by organic matter. There seems to be a well-marked period in the growth of the siphons when they first commence to form spicules, but this, as yet, has not been exactly determined.

* Comptes Rendus, cviii. (1889) pp. 863–5.
† Proc. Boston Soc. Nat. Hist., xxiii. (1888) pp. 380–2 (2 pls.).

The conchiolin tube commences as a closed sac fitting into the sheath of the apical chamber; it extends unchanged in thickness through the first funnel; from the second to the fourth septum the tubes are much attenuated. At about the fifth, the tubes no longer pass through the funnels, but become disconnected. The older funnels are made up of five layers:—(1) an outer layer formed by the anterior end of a posterior sheath, where it embraces the funnel; (2) a darker and denser layer than the outer layer which contains more organic matter; (3) the shell layer of the funnel proper; (4) the dense layer forming the anterior end of an anterior spicular sheath; and (5) an inner layer that is extremely short, and reduces the opening of the funnel at its posterior end. The last two layers are not present in the funnel of the living chamber.

So-called Organ of Verrill in Cephalopoda.*—Dr. J. Brock points out that the so-called organ of Verrill in Cephalopods was discovered and described by Heinrich Müller more than thirty years ago, while Bobretzky has made some observations on its development. The recent statement of Mr. Laurie that the organ is absent from the adult *Loligo* and *Ommastrephes* is probably due to the fact that preserved material only was examined; Müller himself was aware that the funnel-organ was completely destroyed by the ordinary preservative fluids. The organ, indeed, has been seen in so many Cephalopods that it may well be said to be found in the class as such. The author confirms the account given by Müller as against the discrepant description of Laurie.†

β. Pteropoda.

Morphology of Spinous Sacs of Gymnosomatous Pteropoda.‡—Dr. P. Pelseneer objects to the view recently enunciated by P. Schalfejeff as to the homology of the "sacs à crochets" with any part of the arms of Cephalopoda. These arms and the organs which they carry are entirely pedal in nature, while the sacs of all the Gymnosomata are inserted on the internal wall of the buccal cavity. As the Aplysina have the greatest affinities to the Gymnosomata they should be examined when it is sought to explain the nature of the sacs; now, in *Notarchus* the buccal cavity is lined by spinous hooks, and those found in the Pteropods are only specializations of the spinous palatine vault of *Notarchus*. It is to be noted that the sacs are not always as long as in *Clione* or *Pneumodermon*; in *Dexiobranchæa*, which is the most primitive of existing Gymnosomata, and in *Clionopsis* they only form slight depressions in which the hooks are implanted.

γ. Gastropoda.

Ventral Nervous Mass of Fissurella.§—Dr. L. Boutan deals with some criticisms of Dr. B. Haller. That author has asserted that the ventral nervous mass forms a homogeneous centre in which two distinct portions cannot be made out; and that the centre is single. Dr. Boutan declares that this is not the case, for two centres may be fused histologically, and yet be distinct morphologically, and this is the case with *Fissurella* and a number of other Molluscs.

* Nachrich. K. Gesell. Göttingen, 1888, pp. 476–8.
† See this Journal, 1888, p. 932.
‡ Zool. Anzeig., xii. (1889) pp. 312–4.
§ Arch. Zool. Expér. et Gén., vi. (1888) pp. 375–421 (3 pls.).

The study of a series of sections shows that the histological separation of the centres is not more marked in the upper part of the nervous mass, where authors seem to agree in recognizing the presence of pedal ganglia and the first two asymmetrical ganglia, than in the lower part of the nervous mass. The study of larvæ shows that the ventral mass is certainly formed of two distinct nerve-centres (first two asymmetrical ganglia and pedal ganglia). If it is impossible to establish a histological distinction between the two centres, on account of the continuity of the layer of peripheral nerve-cells, it is quite easy to distinguish in the nervous mass, by the aid of the groove and of the two orders of nerves, what part belongs to either of the fused centres. An examination of sections shows that the general form of the four ganglia which serve to form the nervous mass as a whole, is that of four cylinders united by pairs, and closely applied to one another by one of their faces. The structure of the epipodium and the close relations which it has with the mantle in the young *Fissurella* should lead us to regard it as part of the mantle, and to keep for it the name of inferior mantle.

Descent of Ova in Helix.*—M. J. Pérez has investigated the descent of the ova in the canal of the hermaphrodite gland of *Helix*. At whatever season the efferent canal is examined, the inferior part of the tube is always found filled with sperm. It is evident that the ova must pass through the efferent canal a short time before they are found in the diverticulum. The author has dissected a large number of specimens day by day. He found in some that the canal was less distended by sperm than usual, and had a peculiar greyish appearance. Microscopic examination of the contents showed that the sperm was more or less completely altered, and that the epithelium of the efferent canal was also being destroyed. When the sperm and epithelium are both completely absorbed, the efferent canal is empty and the way is open for the ova. The author has not yet been able to observe their passage directly, and thinks it is effected in a very short time.

Anatomy of Clione limacina.†—Herr P. Schalfejeff commences by directing attention to the so-called jaws of this mollusc. The walls of the sheath are formed of a thick layer of circular muscles covered by a very thin investment of connective tissue. When at rest the jaws have, externally, a layer of longitudinal muscles, part of which forms the retractor of the seizing apparatus; the spaces between the muscles contain connective substance which forms a thick layer of fibrous appearance, a cylindrical epithelium, and an armature of hooks which is connected with the epithelium. The hooks consist of a horny substance which is not chitin, and rests on giant-cells, the finely granular protoplasm of which fills up the hollow of the tooth, as far as its tip. Similar characters have been observed in *Pneumodermon*.

As to the connection between the organ of Bojanus and the pericardial cavity, the author affirms that there is not merely an opening, but a typical funnel; the epithelium of this, which is characterized by very long flagella, passes on the one side into the very flat epithelium which covers the inner surface of the pericardial cavity, and on the other into the glandular epithelium of the kidney.

* Comptes Rendus, cviii. (1889) pp. 365–7.
† Zool. Anzeig., xii. (1889) pp. 188–90.

Reproductive Organs of Valvata piscinalis.* — Dr. P. Garnault gives a description of the reproductive organs of *Valvata piscinalis;* at first sight they appear to differ a good deal from those of other androgynous Molluscs, but the resemblances are seen when the relations of the parts are laid down as in a ground-plan. At the same time they are distinguished by the fact that there is a communication between the efferent canal and the copulatory pouch, and this ensures self-fecundation in cases in which copulation is not effected. Further details and illustrative figures are promised.

δ. Lamellibranchiata.

Morphology of Teredo.†—M. A. Ménégaux has investigated the homologies of the different organs of this aberrant Lamellibranch. Having discovered the anterior adductor-muscle, he is able to say that it is a dimyarian; this muscle is very small, is covered by a pallial lobule and separated from the posterior adductor by the rectum and a vessel which accompanies it. The "palettes" are moved by three special muscles, the largest of which arises from the siphonal muscles, the other two are lost in the mantle. The single aorta corresponds anteriorly with the anterior and posterior aortæ of other Lamellibranchs, but after it has passed the posterior adductor it no longer corresponds to the posterior aorta. To the right of the rectum it gives off two lateral pallial vessels; then it passes slightly to the right, follows the right siphonal nerve and gives off a branch to each of the siphons. This asymmetry of the circulatory system is more apparent than real; it reminds one of what obtains in *Pholas,* and the difference is due to the fact that the mantle of *Teredo* being greatly developed in a longitudinal direction the posterior aorta is of considerable length before it bifurcates to go to the siphons.

Origin of Unionidæ.‡—Prof. M. Neumayr has no doubt that the great stock of the Mollusca was originally developed in the sea. Of the fresh-water groups now existing, the most widely distributed and important of the Lamellibranchs are the Unionidæ, which appear to be descended from the marine *Trigonia.* This form has the hinge of the peculiar schizodont type, and, though the hinge-structure is exceedingly variable in the Unionidæ, we find on close examination of normal forms that they may be referred to the same type. Affinity is also shown by the structure of the gills, the separation of the two lobes of the mantle, and the absence of siphons. In both groups the nacreous shell exhibits extraordinary development, there is a strong epidermis and a resemblance in the arrangement of the muscular scars. It is particularly remarkable that in many geologically young *Uniones* of Pliocene and recent times shell-ornaments appear as retrogressive structures, such as occur elsewhere only in the *Trigoniæ.*

Molluscoida.

α. Tunicata.

Developmental History of Distaplia magnilarva.§—In the first of his memoirs on the development of this compound Ascidian, Dr. M. v. Davidoff deals with the maturation of the egg. The structure which is

* Zool. Anzeig., xii. (1889) pp. 266–9.

† Comptes Rendus, cviii. (1889) pp. 537–8.

‡ Anzeig. K. Akad. Wiss. Wien, 1889, p. 4; Ann. and Mag. Nat. Hist., iii. (1889) p. 372.

§ Mittheil. Zool. Stat. Neapel, ix. (1889) pp. 113–78 (2 pls.).

generally known as the egg in Ascidians is not what is ordinarily regarded as such; it is rather an ooblast which produces eggs, and it is consequently comparable to the ooblast of the Appendicularia (*Fritillaria*). The eggs produced by the ooblast function as such in the Appendicularia, while in Ascidians only one is capable of fertilization; all the rest become aborted and may be spoken of as testa-cells. The nuclei of all the eggs arise as buds of the nucleus of the ooblast or karyoblast. In Ascidians they are formed as simple constrictions of parts of the membrane and reticulum of the karyoblast, without the intervention of the nucleolus. On the surface of the ooblast of *Distaplia* they increase karyokinetically. Later on the muscular buds or nucleogemmæ become surrounded by part of the protoplasm of the ooblast; and thus become cells, and separate from the ooblast. The eggs of the Appendicularia retain, on constriction, a follicular investment, with which the complex of ooblasts of these animals is from the first surrounded. In Ascidians the abortive eggs do not retain any covering, but lie in the space between the egg and the follicular epithelium.

There is reason to suppose that the reduction of the eggs formed by the ooblast goes still further than is the case in Ascidians. The nucleogemmæ lose their specific protoplasmic covering and become lost in the ooblast. The various phenomena of formation of buds of the karyoblast which have been several times observed in Vertebrates are probably of the same character. In later stages of cleavage it may be seen that some of the abortive eggs of *Distaplia* are entirely the large endoblast cells, while others remain for some time without taking any part in forming the tissues of the larva. When the abortive eggs have left the ooblast the latter forms a true egg. All the protoplasm of the egg breaks up into yolk-bodies in such a way that no intermediate substance is retained. At the same time the membrane and reticulum of the germinal vesicle become lost in its karyoplasm and are converted into a plasmatic, actively moving, amœboid body, which gradually extends itself in a plexiform fashion in the whole egg (ergoplasm). The nucleolus, which has till now remained passive, is converted by internal histological differentiation into a "polar nucleus" with membrane, nuclear network, and nucleolus. By the action of the ergoplasm the polar nucleus is conveyed to the periphery of the egg; it loses its membrane and network, its chromatin becoming converted into chromatic loops, which give rise to a chromatic figure when the polar globule is constricted off. It behaves therefore just as the germinal vesicle is known to do. The formation of one polar globule was observed, and this must be regarded as cell-division. Bütschli's hypothesis that the polar globules are rudimentary eggs is so far supported by what obtains in *Distaplia* where the abortive eggs are all of the same size after their division. The cleavage nucleus is surrounded by a large quantity of ergoplasm; when observed it was found to consist of a large number of similar merites. The ergoplasm is to be identified with the protoplasm of Kuppfer.

β. Bryozoa.

Anatomy of an Arenaceous Polyzoon.*—Mr. A. Dendy describes a remarkable new genus of ctenostomatous Polyzoa, found near Port Phillip Head, which he calls *Cryptozoon*, and of which two species, *C. wilsoni* and

* Royal Soc. of Victoria, 1889, 8vo, 11 pp. and 3 pls.

C. concretum, have been distinguished. The organism forms tubular, chitinous zoœcia enveloped in common aggregations of sand; the polypides are provided with a muscular gizzard containing two horny teeth. The chief difficulties in the way of the study of the soft tissues consist in the very minute size of the individual polypides, and in the difficulty experienced in separating them from the mass of sand-grains in which they are enveloped and to which the zoœcia firmly adhere.

The cœnœcium is dichotomously branched and the branches come off in several planes; it consists primarily of a slender chitinous tube; the whole is divisible into what may be termed nodes and internodes; the former are dense aggregations of grains of sand firmly held together by the chitinous zoœcia, while the latter are longer or shorter, slender, chitinous tubes connecting the nodes together. It is to be especially noted that the tubular internodes are not continuous through the substance of the sandy nodes, but each, on entering the sandy mass, breaks up into a kind of *rete mirabile*, formed chiefly of the delicate tubular zoœcia. The zoœcia are very delicate, and it is possible that, in *Cryptozoon*, as in those horny sponges which take on an arenaceous habit, the chitinous portion of the skeleton is actually reduced in consequence of the addition of the sand, which may be considered as supplementing, and, possibly, to a certain extent replacing the chitin. The wall of each internode appears in optical longitudinal section to be clothed internally with a deeply staining epithelium, the cells of which secrete the chitinous wall of the tube; this lining is, no doubt, a direct continuation of the cœlomic epithelium of the polypides, and appears to be the only organic connection between the different members of the colony.

So much of the anatomy of the polypide as could be made out is described. The epithelium of the tentacles does not present the same character over the whole surface; on the inturned face of each tentacle there are two parallel longitudinal rows of small, columnar cells, each of which contains a relatively large, deeply staining nucleus. The cilia on the tentacle are nearly as long as the tentacle is thick, and they always move in a perfectly definite and regular manner. The alimentary canal is very complex, and five distinct parts—pharynx, œsophagus, gizzard, stomach, and intestine—can be recognized in it.

The gizzard is globular in shape, and has thick muscular walls, consisting mainly of a stout circular band of muscles oval in section, and composed of a great number of delicate fibres, surrounding two relatively large chitinous teeth. These last are squarish in shape, and flattened. The stomach is very large, elongated and saccular, and is differentiated by the character of its lining membrane into two totally distinct regions—an upper, non-digestive, and a lower, digestive portion. The entire alimentary canal is clothed externally by a delicate, closely-fitting, flattened epithelium, the nuclei of which are plainly discernible over the greater part of its surface. The muscular system is well developed.

The author remarks that it is interesting to find a Polyzoon acquiring a habit with which we are already familiar in other groups, such as Foraminifera, Sponges, and Annelids. The genus is obviously closely allied to *Bowerbankia*, from which it differs most markedly in the habit of agglomerating particles of sand on to the zoœcia. In conclusion, the distinctive characters of the new species are briefly enumerated.

Structure and Metamorphosis of Larva of Flustrella hispida.*—M. H. Prouho has made a study of the larva of this Bryozoon. In the oral region there is a pyriform organ with a vibratile plume and a sucker, and in the aboral region an ectodermic pad; the two regions are separated by a ciliated corona. In addition to these there is an internal hollow organ, the cavity of which communicates with the exterior by an orifice on the oral surface between the pyriform body and the sucker; it may be regarded as an embryonic digestive sac. As the larva approaches the free stage the walls of the sac become less and less distinct, and are finally absorbed. In this point the free larva differs essentially from *Cyphonautes*, in which, as all agree, there is a digestive tube. The ectoderm and mesoderm become considerably differentiated in the free larva. A bundle of nerve-fibres, with which are connected some unipolar cells, directly connects the pyriform organ with the aboral pad. Some of these fibres extend as far as the vibratile plume and make their way between the glandular cells of the pyriform body, while a right and a left bundle become detached to furnish fibres to the ciliated cells of the groove, to those of the corona, and to the very numerous vibratile swellings which are scattered over the dorsal surface. As all the ciliated cells of the larva are connected with the aboral ectodermic pad, and as this is provided with rigid cilia, it appears to be justifiable to regard it as having a sensory function.

On each side of the larva there are parietal muscles comparable to those of the adult, and longitudinal muscles, which are adductors of the valves, traverse the middle of the larva. The most interesting mesodermal structure, and one which has not yet been noticed in the larvæ of marine ectoproctous Bryozoa, is a subepidermic cellular layer which is particularly developed in the aboral region.

When the larva becomes fixed the corona is folded inwards, and the sucking plate fuses with the skin all round the free edge of the valves; the changes which now occur agree with what are seen during the fixation of a cheilostomatous larva. The corona, pyriform body, nervous system, and a portion of the musculature then undergo degeneration, and form a mass of globules enveloped by the mesodermic layer. The thickened plate of the ectoderm soon afterwards proliferates rapidly, and forms an invagination below the cuticle, which does not itself take part in it.

Arthropoda.

Segmental Sense-Organs of Arthropods.†—Mr. W. Patten states that the cephalic lobes of *Acilius* are composed of three segments, each of which contains a segment of the brain, optic ganglion, and optic plate. It is very probable that these characters are common to all Insects. The segmental nature of the eyes is more clearly seen in the embryos of scorpions, spiders, and *Limulus*, where it can be shown that they are serially homologous with one or more pairs of sense-organs on each segment of the thorax. If the cephalic lobes of scorpions could be stretched out the eyes would lie, as in *Acilius*, on the thickened outer edge of each segment. This thickened edge is represented in the post-oral region of the pleuræ of the thoracic segments, each of which bears two large sense-organs close together near the outer edge of the

* Comptes Rendus, cviii. (1889) pp. 1023–5.
† Journal of Morphology, ii. (1889) pp. 600–2.

base of the legs. Mr. Patten thinks it is clear that the eyes are serially homologous with these thoracic sense-organs. The latter contain a cavity, shaped like the bowl and stalk of a goblet, lined with striated cuticle similar to that found at an early stage over the eyes of *Acilius*. The ventral cord and brain of Arthropods are at first composed entirely of minute sense-organs, which in scorpions have the same structure as the segmental ones at the base of the legs. Further details are promised.

α. Insecta.

Formation and Fate of Polar Globules in Eggs of Insects.*— Dr. H. Henking has examined the early stages of development in the eggs of various Insects.

In the egg of *Pyrrhocoris apterus* the first polar globule appears three or four hours after deposition; it lies in a shallow depression of the marginal zone of protoplasm; below it may be seen the second globule in a more or less advanced stage. When the first embryonic cells begin to be formed within the egg, the globules come to be placed freely in a cavity which is altogether surrounded by the marginal protoplasm; they have not yet, however, acquired their definite position. In eggs about twenty hours old the globules lie outside the protoplasm on the surface of the ventral yolk-material. The author's opportunities of observation have not as yet enabled him to definitely settle the fate of these bodies, but he is satisfied that the globules are again taken up by the egg. In the case of various Lepidoptera, Diptera, and Hymenoptera, Dr. Henking has not been able to observe the expulsion of the polar globules. In *Tenebrio molitor* one is certainly expelled, and the same is the case in *Lampyris splendidula*.

Vision of Insects.†—Dr. F. Dahl, who believes that Insects can distinguish form, traverses certain conclusions of Prof. Plateau, for which he does not believe there are physiological grounds. He relates an account of an experiment which he made with a bee (*Hylæus morio*), whose enemy is the spider *Attus arcuatus*; thinking that the olfactory sense might give the insect warning, he killed a spider, and smeared a paper-sphere with its blood, but of this the bee was not at all afraid. The male of the dipterous *Dolichopus plumipes* has a beautiful and regular pinnation of the first tarsal joint of the middle leg; this apparatus cannot be of use during copulation. When the insects were pairing it was observed that the male hovered over the female in such a way as to bring its middle tarsi close to the eyes of the female.

Dr. D. Sharp ‡ devoted a large part of his Presidential Address to the Entomological Society of London to the subject of the vision of Insects. He thinks we may fairly conclude that it is quite uncertain what insects do see, or whether they see at all, if we use the word seeing in association with our own plane-picture seeing. He lays stress on the point that, certain central structures in connection with the vertebrate sense of sight not being present in insects, other structures to compensate for their absence may be expected to occur in more direct connection with the eye. If so, it becomes highly probable that the functions of the insect-eyes are not only dissimilar from ours, but are

* Nachr. K. Gesell. Göttingen, 1888 (1889) pp. 444–9.
† Zool. Anzeig., xii. (1889) pp. 243–7.
‡ Trans. Entomol. Soc. Lond., 1888 (1889) pp. xlviii.–lxix.

also more complex. He thinks that, from the anatomical side, we as yet know very little about how or what an insect sees, and he thinks it highly probable that its sight is very different from our own, and that continuous picture-vision forms no part of it; he thinks it possible that the compound-eye may have two or three distinct kinds of perception. At the same time he is of opinion that the ocular powers of insects are very perfect in their way, although that way may be very different from ours.

Hermaphroditism in Gastropacha.*—Prof. P. Bertkau describes a case of external hermaphroditism in *Gastropacha quercus*, where the right antennæ and wings were those of a female, those on the opposite side characteristically male. In other ways the external secondary characters were mingled, but the thorax and posterior body were wholly female. The state of the internal organs was at the same time investigated, obviously a point of much importance. The gonads were wholly degenerate, but there were almost normal female ducts and auxiliary structures. There was no hint of internal male organs. Bertkau believes that an individual has rudiments of both kinds of secondary sexual characters, that predominance of one sex in the organism suppresses the secondary features of the other, while complete atrophy of the essential organs is naturally enough associated with an external average. The author notes the occurrence of 315 cases of "hermaphroditism" among Arthropods:—8 Crustaceans, 2 Arachnids, 305 Insects. Of the latter, 244 Lepidoptera, 48 Hymenoptera, 9 Coleoptera, 2 Orthoptera, and 2 Diptera are known. Among Arachnids, a specimen of *Diæa dorsata* was male as regards cephalothorax, limbs, and palps, but female in the hinder part of its body.

Myrmecophilous Insects.† — Herr E. Wasmann continues his interesting investigations on the life of myrmecophilous beetles and their relations to the ants. He distinguishes (1) true guests which are cared for and fed by the ants (*Atemeles*, *Lomechusa*, *Claviger*); (2) forms which are tolerated but are not treated with special friendliness, and which feed on dead ants or rotting vegetable material (*Dinarda*, *Hæterius*, *Formicoxenus*, &c.); (3) ant-eating species, pursued as enemies, or only tolerated as a matter of necessity (*Myrmedonia*, *Quedius brevis*, &c.), to which may be added parasites like *Phora*. The three sets are not rigidly separable.

Atemeles and *Lomechusa* have taken on some of the habits of their hosts, and are more adapted than other myrmecophilous insects. The best known species of *Atemeles* (*A. paradoxus* and *A. marginatus*) are found most frequently in the nests of *Myrmica*, more rarely in those of *Formica* and others. On the contrary, *A. pubicollis* seems to be more frequent in *Formica* nests. The species of *Atemeles* are lively animals, constantly moving their feelers, and experimenting with everything. If one be attacked by a hostile ant, it first seeks to pacify its antagonist by antennary caresses, but if this is unavailing it emits a strong odour which appears to narcotize the ant. Wasmann describes how the ants feed the *Atemeles* and are caressed and licked for their care, how one

* Verh. Nat. Ver. Preuss. Rheinld. (SB. Niederrhein. Gesell.), xlv. (1888) pp. 67–8.

† Biol. Centralbl., ix. (1889) pp. 23–8; Deutsche Entom. Zeitschr., 1886, pp. 49–66, 1887, pp. 108–22; Tijdschr. v. Entom., xxxi. (1888) p. 84.

Atemeles feeds another, or even as a rarity one of the hosts. Yet the beetles feed independently on sweet things, dead insects, and even the unprotected young of the ants. The guests are licked and cleaned by the hosts, as well as *vice versâ;* but the beetles are in reality quite dependent upon the ants.

As to *Lomechusa*, it is represented in Central Europe by a single species, *L. strumosa*, which is almost always found with *Formica sanguinea*, though occasionally with other forms. This beetle is much larger, plumper, and more helpless than *Atemeles;* its odour is different and very like formic acid; its relations to the hosts are more passive, yet it can feed independently, for instance, on the larvæ and pupæ of the ants.

The other guests are rather pests than pets. They almost all live on animal food, are often protected simply by prestige or by their odour. The minute *Oligota*, *Homalota talpa*, *Myrmecoxenus*, *Monotoma*, *Hysteridæ*, the small guest-ant *Formicoxenus* in the nests of *Formica rufa*, &c., appear to escape unnoticed.

On a change of abode, the myrmecophilous insects follow their guests, or, as in the case of *Lomechusa* and *Atemeles*, they are taken with them by force. While the ants themselves are well known to be very exclusive, the guests can be shifted from nest to nest or even from species to species. As Wasmann says, the guests seem to have "international relations."

In commenting upon the above facts, Prof. Emery regards it as certain that the semi-domesticated, and in one sense parasitic forms like *Atemeles* and *Lomechusa*, are descended from thievish forms. They retain some of the original traits, just as dogs and cats do in their recently acquired tamed state.

Butterflies' Enemies.*—Mr. S. B. J. Skertchly, who has had opportunities of studying the question in virgin forest, discusses the habits of the enemies of Butterflies. He comes to the conclusions that mimicry is a protection from foes which attack butterflies on the wing; protective resemblance is a protection from foes which hunt sleeping prey; mimicry was a protection from birds, but birds seldom attack butterflies now, though butterfly-catching birds were formerly more plentiful. The comparative rarity of mimicry shows the danger to have been of relatively short duration. The shyness of butterflies is a further proof of danger; it is now probably an inherited instinct. Protective resemblance is almost universal, and is a protection during the sleeping hours. Ants seldom capture living butterflies. The symmetrical mutilations of butterflies point to lizards and perhaps small insectivorous mammals as the foes which hunt for sleeping butterflies. It is concluded that the amount of danger feared is measurable by the efforts made to avoid it.

Alimentary Canal of Larval Lamellicorns.†—Sig. P. Mingazzini communicates some new facts in regard to the structure of the alimentary canal in the larvæ of some phytophagous Lamellicorns, belonging to the genera *Oryctes*, *Anomala*, *Cetonia*, and *Tropinota*. He notes the presence of unstriped muscles in the mesenteron, for at least a period of the larval life, and describes a new type of connective tissue and crystalloids in the

* Ann. and Mag. Nat. Hist., iii. (1889) pp. 477-85.
† Boll. Soc. Nat. Napoli, ii. (1888) pp. 130-4.

nuclei of some cells in the midgut of *Oryctes*. The median ventral groove of the midgut in the larvæ of *Oryctes*, *Cetonia*, and *Tropinota* is a sort of glandular cæcum with a digestive secretion. The sac which forms the median portion of the proctodæum is the absorptive part of the intestine in these larvæ.

Bees and Flowers.*—Dr. M. Kronfeld corroborates the old observation, which even Aristotle recorded, that bees do not fly at random from one flower to another, but for a longer or shorter period restrict their visits to one species. Three times before a bed of *Cucumis* the observer detained a bee, and watched it return when liberated to the same kind of flower though others were there in abundance. At a bed including eight different kinds of flowers the bees were apparently blind to all but one species. In a meadow with abundance of inviting flowers, representing nearly a score of species, Herr Kronfeld saw a humble-bee visit within ten minutes twenty-eight heads of goat's-beard, and no others. The observations, therefore, show a considerable degree of constancy in the bees' visits.

Stigmata of Hymenoptera.†—M. G. Carlet finds that the stigmata of the Hymenoptera are always open, and that there is not the least trace, at their orifice, of any obturator apparatus. They are of extremely small size, and have, consequently, received but little attention; moreover they are generally covered externally by hairs which are often ramose, and which serve to prevent the introduction of foreign bodies, even in the form of fine dust. The tracheal trunks may be opened or closed at the will of the insect; this mode of closure, which the author calls opercular, is effected by means of a special tracheal muscle which is inserted in the trachea, above a cleft which is found on it in front of the stigma; the tracheal muscle raises the upper lip of this cleft, that is to say the operculum, in the mode of the lid of a snuff-box. The difficulty of the investigation to which M. Carlet has lately devoted himself may be estimated from the fact that this muscle is more delicate than the finest silk-thread of commerce.

Development in Egg of Musca vomitoria.‡—Dr. A. Voeltzkow has published a full account of his researches on this subject. To our notice of his preliminary communication § we may now add the following. The Malpighian vessels are formed as evaginations of the hind-gut, and the sucking stomach as an evagination of the fore-gut. The salivary glands are formed by invagination of the ectoderm in the anterior part of the head and are laid down separately; later on they open by a common efferent duct into the mouth. The ventral cord, when fully developed, consists of two longitudinal cords of nerve-fibres which are inclosed by nerve-cells; in correspondence with each segment the nerve-cells are separated by a ventral mass of cells. The longitudinal trunks lie close to one another, but do not fuse, being separated where they touch by a fine layer of cells. In the course of its further development the ventral cord shortens considerably; the author does not agree with Weissmann that the indications of the earlier segments are lost. He is

* Biol. Centralbl., ix. (1889) pp. 28–30.
† Comptes Rendus, cviii. (1889) pp. 862–3.
‡ Arbeit. Zool.-Zoot. Inst. Würzburg, ix. (1889) pp. 1–48 (4 pls.).
§ See this Journal, 1888, p. 572.

inclined to accept Hatschek's statement that the brain arises from the lateral parts of ectoderm laid down separately.

A Spinning Dipteron.*—Prof. J. Mik describes a remarkable veil which the male of *Hilara sartor* Beck. carries about with him in his flight. This veil is a thick filamentous tissue, without any "sort of seam in its longitudinal axis," or "S-shaped threads," as Becken describes. It is not borne on the back of the abdomen of the male, but is held on the under surface of the body by the feet.

Biology of Gall-producing Species of Chermes.†—Dr. F. Löw has a contribution to the interesting subject of the biology of gall-producing species of *Chermes* which is now attracting so much attention. His experiments enable him to confirm two of the statements of Blochmann and Dreyfus—the wandering of the winged individuals of the first or gall-generation of *Chermes abietis* from the pine to another species of Conifer, and the division of this generation into two unequal parts, each of which forms the commencement of a special series of developmental changes. He also makes a contribution to the literary side of the question.

Dr. L. Dreyfus ‡ has again § a communication on the subject; he finds that *Ch. hamadryas* must cease to be regarded as an independent species, and the animals which have been so called must be considered to belong to the developmental series of *Ch. strobilobius;* there are, therefore, no species which can now be said to be confined to the larch.

Egg of Melolontha vulgaris.‖—Dr. A. Voeltzkow has made a study of the development of the egg of *Melolontha vulgaris*, but unfortunately he was not able to investigate the earliest stages. The germinal layers are formed in the manner first described by Kowalevsky for Insects, namely, by invagination in the middle line of the germ-stripe, the groove thus formed being converted into a tube; this tube is flattened out in a dorso-ventral direction, becomes cut off from the blastoderm, and differentiated into an outer and an inner layer. The cells of either layer fuse completely with one another, so that no sign is left of the previous tube or cleft. The author is not in agreement with Heider, for he is unable to accept the account of the differentiation of the lower layer into two distinct cell-layers. A very important point in Heider's memoir is the account of the formation of the mid-gut; but Dr. Voeltzkow's own investigations, coupled with a critical notice of the work of other observers, seem only to lead him to the conclusion that the question of its origin is well worthy of renewed investigation, which he proposes to take with *Blatta* as his subject.

Anatomy of Blattidæ.¶—Dr. E. Hasse states that Mr. E. A. Minchin's lately discovered ** organs in *Periplaneta orientalis* are, as their discoverer supposed, stink-glands; it may be easily proved in the larvæ. The hairs which take up the secretion of the glands and diffuse it call to mind those described by Fritz Müller as associated with the stink-clubs of the females of *Maracuja*. In both the secretion appears to be of an oily character. Comparable also are the eversible dermal

* Verh. K. K. Zool.-Bot. Gesell., xxxviii. (1888) pp. 97–8.
† Zool. Anzeig., xii. (1889) pp. 290–3.
‡ T. c., pp. 293–4. § See this Journal, *ante*, p. 380.
‖ Arbeit. Zool.-Zoot. Inst. Würzburg, iv. (1889) pp. 49–64 (1 pl.).
¶ Zool. Anzeig., xii. (1889) pp. 169–72. ** See *ante*, p. 204.

appendages found by Gerstäcker in *Corydia*, and the structures of similar function found in larvæ, and lately described by Klemensiewicz. Some account is given of the peculiar organs found between the sixth and seventh dorsal plates of *Phyllodromia germanica*.

β. Myriopoda.

Spinnerets of Myriopoda.*—M. J. Chalande found in *Scolopendrella immaculata* an apparatus composed of two distinct glands, which open outwards in the two appendages which are placed on the margin of the anus. They have the form of elongated tubes which end blindly about the fifth anal segment. The anterior portion forms the gland proper and the hinder part its excretory canal. The gland is occupied by a single large cavity filled with the secreted substance; its wall consists of fine cells charged with fine granulations. The terminal appendages, which are formed by a single lanceolate joint ending in a long and strong spine, are traversed by a cavity at the end of which is an aperture. The secreted liquid is remarkable for its great viscosity, and does not mix either with water or glycerin; on coming into contact with air it hardens rapidly. The threads thus formed differ from those of Spiders in being not elastic but fragile, like a thread of glass.

Myriopoda of Mergui Archipelago.†—Mr. R. I. Pocock has an account of the Myriopods collected by Dr. Anderson; they are, apparently, the first recorded from these islands, and they are, in many cases, referable to species which have been described from the Oriental region. Those that are new are, with one exception, small and inconspicuous individuals, which would in all probability have been overlooked or ignored by any but a scientific collector. Of the Chilopoda only one —a species of *Himantarium*—is new; of the Diplopoda, *Glomeris* has one, *Paradesmus* two, *Spirostreptus* two, and *Spirobolus* one new species. During the printing of his paper the author was enabled to examine two large collections of Burmese Myriopods, and he has now found that the Myriopod fauna of Mergui has certainly been derived from that of South Burmah. He has therefore described the new *Glomeris* from Mergui not as a new species, but as a variety of a new *Glomeris*—*G. carnifex*—from Tenasserim, arguing that the continental form is the parent of that found in the island.

γ. Prototracheata.

Maturation of Ovum in Cape and New Zealand Species of Peripatus.‡—Miss L. Sheldon has had the opportunity of studying the maturation of the ovum in three species of *Peripatus*. In *P. capensis* and *P. Balfouri* the ova arise by a growth of some of the nuclei of the germinal epithelium; apparently any of the nuclei may give rise to ova. Each ovum has a large round central nucleus, and is surrounded by a layer of protoplasm, which is not separated from that of the germinal epithelium. As the ova increase in size they become surrounded by a thin shell. As the nucleus passes to the periphery it is homogeneous, and has only slight traces of a reticulum. After the disappearance of the germinal spot the wall of the germinal vesicle becomes irregular in

* Comptes Rendus, cviii. (1889) pp. 106–8.
† Journ. Linn. Soc. Lond., xxi. (1889) pp. 287–303 (not 330 as printed) (2 pls.).
‡ Quart. Journ. Micr. Sci., xxx. (1889) pp. 1–29 (3 pls.).

outline and then disappears, its contents becoming fused with, and indistinguishable from, the cell-substance. As the ovary is full of spermatozoa the ova are probably fertilized in it. They thence make their way into the uterus. The youngest uterine ovum observed had no nucleus; a small spindle appears at one point at the periphery of the egg, and a male pronucleus is present at the opposite side. The spindle divides twice to form polar bodies, and the remainder of the spindle remained as the female pronucleus; it lies at a little distance from the surface, and is lobed. The male pronucleus is large and rounded; the two probably conjugate, though this has not been observed. The resulting nucleus passes to the periphery; it is large and lobed, and soon becomes surrounded by a large mass of dense protoplasm.

An account is also given of the maturation of the ovum in *P. Novæ-Zealandiæ*, which differs not inconsiderably from that of the Cape species; for example, spermatozoa are present in the receptacula seminis and not in the ovary; the nucleus is at one period vacuolate, and no polar bodies have as yet been observed.

In conclusion some general remarks are made on the origin of the ova from germinal epithelium, the disappearance of the germinal vesicle, the formation of the polar bodies, and the formation of the yolk. As to the last question; while it has been suggested that the yolk arises in the protoplasm of the egg itself, from the breaking up of the germinal vesicle, or from the follicle cells, it is of interest to observe that *P. Novæ-Zealandiæ* not only affords an example of all these three methods, but also a fourth, for the yolk arises from yolk which is present in the ovary itself. Miss Sheldon does not think she could have failed to see polar bodies in *P. Novæ-Zealandiæ* had they been formed, and she thinks that their absence in that species and their presence in the Cape species can only be explained by supposing that they are in some way dependent on the yolk, since in it lies the main difference between the eggs. If this be so, it is clear the polar bodies cannot have the significance which Weismann attributes to them, and in any case the similarity between the two polar bodies in the Cape species is not what we should have expected if their meaning were so different as Weismann suggests.

δ. Arachnida.

Life-histories of Glyciphagus domesticus and G. spinipes.*—Mr. A. D. Michael finds that there is a hypopial stage in the life-history of *Glyciphagi*, just as there is in that of *Tyroglyphus*, but it is far less developed, and is not, so far as is known, an active stage. At present we do not know whether it occurs in all species, but we do know that it does not occur in the life of every individual of a species. The stage is not the result of desiccation and other unfavourable circumstances, but occurs as often under favourable conditions. In the species investigated it occupies the period between the penultimate ecdysis and that immediately previous.

In *G. spinipes* the *Hypopus* is fully armed, and capable of moving its legs, but not of walking or other active movement; as a rule, it does not leave the skin of the young nymph within which it is formed; the more adult nymph is formed within the *Hypopus* while the latter is still within the young nymphal skin. In *G. domesticus* the hypopial stage is

* Journ. Linn. Soc. Lond., xx. (1889) pp. 285-98 (1 pl.).

even more rudimentary, its representative retaining only the general form of the creature, and having no legs or other external organs.

Encystation of Glyciphagus.*—M. P. Mégnin describes the process of encystation in *Glyciphagus cursor* and *spinipes*. When extinction appears inevitable the following remarkable life-saving modification was observed. The organs liquefy, their substance forms a gelatinous spherical mass within the body, and this mass becomes enveloped in a cyst. This remains inert, but may be blown about like a seed with the body as a parachute. If it land in favourable environment, rapid segmentation and budding occur within the cyst, and a new *Glyciphagus* emerges. M. Mégnin reports a case where myriads of these Acarids appeared very inopportunely from their cysts in a preserved-meat manufactory, which some years previously had been used for the production of bone buttons.

New Genus of Hydrachnids.†—Herr F. Koenike describes a new genus of Hessian Hydrachnida, which he calls *Teutonia primaria;* it appears to be allied to *Limnesia* and *Sperchon*, and to connect these genera with one another.

Accidental Parasitism on Man of Tyroglyphus farinæ.‡—M. R. Moniez deals with the occasional presence on Man of this common Acarid. It was observed at Lille during the handling of wheat imported from Russia and arriving in so dry a state that no kind of fermentation could go on, so that there was no food for the mites. It is probable that they were cast into the air, and so reached the skin, where their powerful organs enabled them to pierce the skin and suck the fluids beneath.

Marine Acarina of the Coasts of France.§—M. Trouessart thinks that the Acarina which are truly marine—the Halacaridæ—ought to form a distinct family and not a subfamily of the Trombididæ, as, indeed, was proposed by Murray in 1875. The young appear to be carnivorous and the adults herbivorous in habit. Like many other Acarina, they are parasitic when young, and merely commensals when adult. They thrive well in brackish water, and resist for a long time the influence of fresh water. They abound in the coralline zone. In the monograph which M. Trouessart has in preparation seventeen species will be described, while English naturalists have as yet only reported the presence of ten on our coasts; several of them are, of course, common to the two faunæ.

Marine Hydrachnida.‖—Dr. R. v. Schaub has some notes on the generic and specific characters found in *Pontarachna*, and some observations on the well-known genus *Midea* He comes to the conclusion that *Asperia Lemani* (Haller) is the female and *Nesæa Kœnikei* (Haller) the male of *M. elliptica* (Kœnike).

Morphology and Larvæ of Pantopoda.¶—Herr G. Adlerz communicates some observations on the morphology and development of the Pantopoda. The first part of his paper deals with the homologies of

* Journ. Anat. et Physiol. (Robin), xxv. (1889) pp. 106–10 (1 fig.).
† Zool. Anzeig., xii. (1889) pp. 103–4.
‡ Comptes Rendus, cviii. (1889) pp. 1026–7.
§ T. c., pp. 1178–81.
‖ SB. K. Akad. Wiss. Wien, xcviii. (1889) pp. 163–79 (2 pls.).
¶ Bihang K. Svenska Vet. Akad. Handlingar, xiii. No. iv. (1888) 25 pp. (2 pls.).

the appendages, with special reference to those of *Nymphon strömii* and *Phoxichilidium femoratum*. In a second chapter the author discusses the larval stages of the last-named species.

ε. Crustacea.

Development of Amphipoda.*—Madlle. M. Rossiiskaya has studied the development of *Orchestia littorea*. The egg, which is deep-violet in colour, and oval in form, is covered by a single membrane, the chorion. The first two blastomeres differ slightly in size, and the later segments are still more unequal. Segmentation stops when thirty-two blastomeres have been formed; protoplasm is then detached from the yolk in the form of amœboid cells, which become scattered over the whole surface of the egg. The blastoderm is formed by the approximation of from four to ten cells, which contract their pseudopodia, become polyhedral, and form a small, irregular, white spot. Around this, cells elongate and become divided in the direction of the radii of a circle, whose centre is the blastodermic spot. Although the cells on the dorsal surface multiply, their number does not increase; this shows that they migrate to the ventral surface, where they aid in enlarging the blastodermic spot.

After the blastoderm has completely covered the ventral surface it elongates at one pole much more rapidly than at the other; the former of these poles is the oral, and the other the aboral. At last the whole surface of the egg is covered by the blastoderm.

During the formation of the endoderm, very interesting sections were obtained; these showed that each blastodermic cell of the ventral surface consists of two parts; the external portion has a condensed protoplasm which stains well, while the internal part stains feebly, and seems to contain yolk; in several of these cells there are two nuclei. These sections show exactly the mode in which nutrient matter is taken in. When the blastoderm covers about two-thirds of the surface of the egg, a dorsal organ is formed on one of its sides; this has the appearance of a funnel, and is made up of large pyriform cells with large nuclei. When the blastoderm completely envelopes the nutrient yolk, it secretes the larval tissue, which is very delicate, transparent, and structureless.

As in *Oniscus murarius*, the endodermic cells arise from a small part of the blastoderm. When the dorsal organ has taken up its definite position on the median line of the dorsal surface, the endodermic cells, which, till now, have been multiplying in the interior of the yolk, migrate towards its surface, and form two lateral bands, which are applied against the abdomen; these bands are the walls of the mid-intestine. Shortly after the intestinal tube is completely closed, the cells which form it change in appearance; instead of being flattened and solid they become large, prismatic, and so charged with vacuoles that the protoplasm only forms a delicate layer on their walls. There then appear three grooves, two of which are dorsal and one ventral; the former cut off, so to say, the true intestine from the intestinal sac, the latter divides the rest of the intestinal tube into two hepatic sacs.

The gonads are formed thus; in the dorsal wall of the intestine, at the two lateral points at which they touch the hepatic sacs, the epithelial cells become cylindrical in form, and multiply rapidly; the cells of the hepatic sacs, where they touch the intestine, simultaneously undergo the same changes. Thus there are formed two solid masses of cells, placed

* Bull. Soc. Imp. Nat., 1888 (1889) pp. 561–81 (2 pls.).

on either side of the intestine. These become hollow, and separate from the walls which produced them.

The mesoderm is first formed from the inner cells of paired ectodermic swellings. The nervous system commences with the formation of cephalic ganglia on either side of the head; the ganglia of the ventral chain appear as paired ectodermic thickenings.

Madlle. (Dr.) S. Pereyaslawzewa * describes the development of *Caprella ferox.* The ova have a transparent but very compact chorion, which does not allow of the passage of much colouring matter or preservative fluid. The nucleus, which is placed at the centre of the egg, is surrounded by a thick layer of protoplasm (formative yolk), covered by a layer of nutrient material, which contains a number of fat-drops. After the seventh stage, the segmentation loses its regularity, and becomes more and more difficult to study; as the formation of the blastoderm is being completed, it thickens on the ventral surface along the median line, while remaining more delicate elsewhere. When its formation is completed, and it covers the dorsal surface of the embryo, the boundaries of the cells are no longer recognizable, and the blastodermic layer has the form of a mass of transparent, perfectly clear, bodies, which envelope and close the yolk, As the dorsal organ is being formed, a transverse groove appears on the ventral surface, which carries down the blastoderm into the midst of the vitelline masses; this is the commencement of the abdomen. Simultaneously two lateral prominences appear above the dorsal organ; these represent the two halves of the head, which, therefore, are at first separate from one another. The development of the body occupies fifteen days.

In the course of the growth of the blastoderm, the constituent cells divide in two directions, radial and tangential; the thickest cells of the ectoderm are found in the thickenings which go to form the extremities, and in the ganglia of the ventral chain. The stomodæum is developed shortly before the rectum; both are developed in exactly the same way as in *Gammarus.* The formation of the mesoderm coincides with that of the extremities; at first its elements accumulate in the ectodermal swellings which have given rise to them. In the phases which correspond to this period of development, the mesoderm nowhere forms an intermediary layer between the ecto- and endoderm. Later on, the division of the mesodermic cells becomes very active, they pass the boundaries of the cavities of the swellings, and become collected in places where muscles will be formed. Before, however, these appear, the heart begins to be developed, and as it is developed the dorsal organ disappears.

In describing the development of the endoderm and its derivates, it is pointed out that the hepatic appendages are developed from endodermal cells which form two independent tubes.

British Amphipoda.† —In the first of his notes on British Amphipoda the Rev. Dr. A. M. Norman describes a new genus and some Œdiceridæ. The former, which is called *Megaluropus*, is remarkable for the large round eye which is situated on a greatly projected head-lobe, and the expanded foliaceous branches of the last uropods. It appears to be nearly allied to *Elasmopus.* The new species, *M. agilis*, has been taken

* Bull. Soc. Imp. Nat., 1888 (1889) pp. 582–97 (2 pls.).
† Ann. and Mag. Nat. Hist., iii. (1889) pp. 445–60 (3 pls.).

in the Firth of Clyde, Liverpool Bay, Devonshire coast, Jersey, and Firth of Forth; it is most frequently taken by means of the surface-net at night, and is a very active swimmer.

The Œdiceridæ noticed belong to the genera *Monoculodes*, *Halimedon*, and *Aceros; Aceros phyllonyx* was taken sixty miles north of Peterhead, in 69 fathoms; it may be distinguished from all other British Œdiceridæ by the total absence of a rostrum, and also from *Halimedon*, which it most closely approaches in the form of the gnathopods, by the structure of the antennules, which, in the female, have a remarkably long peduncle.

Amphipod Family of Scinidæ.*—Prof. C. Chun finds that the Amphipoda of Stebbing's family Scinidæ (Tyronidæ of Bovallius, and Fortunatæ of Chun) are pelagic animals which only exceptionally come to the surface in warmer zones; their reduced eyes show that they are adapted to live in imperfectly illuminated regions. But little has been till lately known about their organization, and their place in systematic classifications is open to revision. Prof. Chun would form six sub-orders of the Amphipoda:—1, Caprellidea; 2, Crevettina; 3, Synopidea; 4, Amphipoda Gammaroidea, with the families Lanceolidæ and Vibilidæ; 5, Tyronidæ, with the family Scinidæ; and 6, Hyperinæ, with the three tribes Hyperidæ, Phronimidæ, and Platyscelidæ. In the Tyronidæ the body is not compressed, the head small, the eyes small or rudimentary; the upper antennæ have no secondary flagellum; basal joint of flagellum very large, sword- or lancet-shaped. Lower antennæ rudimentary in females, mandibles and maxillipeds without palps, &c.

Ostracoda of North Atlantic and North-western Europe.†—Prof. G. S. Brady and Canon A. M. Norman have issued a monograph of the marine and fresh-water Ostracoda of these districts; the present memoir treats only of the Podocopa, and is intended to supplement Prof. Brady's well-known monograph of the recent British Ostracoda.‡

Parasitic Crustacea.§—MM. A. Giard and J. Bonnier have a note on an Epicarid parasitic on an Amphipod, and on a Copepod parasitic on an Epicarid. The Epicarid was found parasitic on *Ampelisca diadema*, whence two specimens were taken. They belong to the group of Cryptoniscina, and were both females with young. The whole body is converted into a vast incubatory chamber, closed by two lateral plates which extend from the first to the fifth thoracic segment; they are united along the middle line so as to leave only an aperture at either end for the passage of water. On the dorsal side are five metameric bands, corresponding to the first five thoracic somites; on either side of the body, on each of the wings, there are conical eminences, which are probably the vestiges of limbs. On the head the maxillipeds are alone well developed.

The terminal part of the body is curved towards the rest in such a way as to complete the incubatory chamber by a posterior cavity, which is likewise filled with eggs. This curious parasite is called *Podascon della Vallei*, a new genus being requisite for its reception.

* Zool. Anzeig., xii. (1889) pp. 286–90, 308–12.
† Sci. Trans. R. Dublin Soc., iv. (1889) pp. 63–270 (16 pls.).
‡ See Trans. Linn. Soc. Lond., 1868.
§ Comptes Rendus, cviii. (1889) pp. 902–5.

On a specimen of *Aspidophryxus peltatus* the authors have found the females and two males of a very singular Copepod, which they call *Aspidœcia Normani*. The female has the form of a miniature *Sacculina;* it is fixed to the *Mysis* on which the *Aspidophryxus* is parasitic by a short peduncle, which ends in a sucker, and to the parasite by an elongated cord; on this cord the male was found. Towards the free end of the body were two ovigerous sacs, containing eight to ten segmenting eggs. The males have a form somewhat similar to that of the males of *Sphæronella Leuckarti;* they are fixed by a spiral chitinous filament secreted by cement-glands, and a large sucker allows the parasite to apply its oral apparatus to its host. At the hinder end of the body are two lateral lobes which contain the spermatophoral sacs. This new genus appears to be closely allied to the *Choniostoma mirabile* lately discovered by Hansen, and, with *Sphæronella*, should be placed in the aberrant family of the Choniostomatidæ.

Morphology and Systematic Position of the Dajidæ.*—MM. A. Giard and J. Bonnier offer additional evidence in support of their view that the Dajidæ are intermediate between the Cryptoniscina and the Bopyrina. *Dajus mysidis* has five pairs of appendages, and the fifth pair, which escaped the notice of Gerstaecker, are the best developed and form the greater part of the incubatory cavity. The morphology of the head and thorax differs little from that of the similar parts in the Phryxina. The adult male presents the pleon which is characteristic of *Phryxus*, but the antennæ and rostrum forcibly recall the structure of embryonic Cryptoniscina.

The study of *Dajus* simplifies that of *Aspidophryxus;* the species lent to the authors by Dr. Norman had been determined as *A. peltatus* by G. O. Sars; but it appears to be distinct from that species and may be called *A. Sarsi;* the differences between the two species are minutely pointed out. Certain errors in Sars's original description are so noted, and the correction of them shows that *Aspidophryxus* is more closely allied to *Dajus* than could previously have been imagined.

Tegumentary Coverings of Anatifer and Pollicipes.†—M. R. Koehler points out that the characteristic tegumentary coverings of *Pollicipes* have a very complicated structure, and do not at all merit the name of scales. The chitinous layer of the peduncle has on its surface a series of conical depressions, clothed by a membrane which is continuous with the general cuticle which covers the chitinous layer. This membrane does not, however, stop at the edge of the pit; it is prolonged freely, and forms a kind of cupola, the internal region of which is placed in the layer of chitin and exhibits very elegant longitudinal and transverse striæ, while the outer half has a uniform dark-brown coloration. The internal region contains a rounded concretion which effervesces with acids. The external region is occupied by a whitish mass which completely fills the cavity of the cupola; it is limited internally by a very fine membrane, which fuses with the cuticular layer. It is the whitish mass which gives the white colour to these so-called scales, while their edges are nothing else than the external borders of the cupola. At the base of each cupola there is a rounded orifice which is bounded by a slightly swollen edge; the edges are continuous with a tube, the wall of

* Comptes Rendus, cviii. (1889) pp. 1020–2. † T. c., pp. 755–7.

which is always formed by the same cuticle as that of the wall of the cupola. These tubes traverse the chitinous layer, becoming more delicate as they approach its internal surface, but their lumen always remains perfectly distinct; they take a slightly sinuous course. It is by these tubes that the cupolæ receive the nutrient materials which they require.

The chitinous layer of the peduncle of *Anatifer* has no special covering, but the cuticle-membrane has certain thickenings which, to some extent, recall the arrangements which are observed in *Pollicipes*. These are hemispherical swellings with globules differentiated in their interior; these latter are formed by the cuticle, and are received into pits of the chitinous layer. The formations are more complicated in *Pollicipes*, but in both genera they are continuous with similar fibres which traverse the subjacent chitinous layer in radiate fashion. The structure of the calcareous valves of the capitulum also presents some peculiarities in *Pollicipes*, for the valves are of considerable thickness, and the calcareous plates are divided into three or four strata by secondary layers of the cuticle. The general tissue of the plates is not compact as in other genera, but contains numerous lacunæ, which are absolutely empty.

Vermes.

a. Annelida.

Influence of Nervous System of Annelids on Symmetry of the Body.*—M. L. Roule, who has studied the development of various Annelids, and especially of the Enchytræidæ, attempts a sketch of the development of the nervous system. The nervous centres are of epiblastic origin, and the first is the cephalic or frontal plate; it alone exists in those embryos in which the development is condensed, but it is not so with larvæ. These latter also have a subepiblastic nervous plexus which is chiefly placed under the vibratile oral corona; it sometimes, as in *Lopadorhynchus*, becomes a compact ring. We have here a radially symmetrically nervous system, and the embryos are oval or spherical. The annular plexus is peculiar to the larva, and disappears after the larval stage. The body next elongates and a third nervous rudiment arises in the metasoma; this is the future ventral nerve-cord.

At their first appearance the plates are merely local proliferations of the ectoblast, which are thicker in the centre than at the sides. Changes occur when the mesoblast begins to be developed, for this elongates with the growth of the body, and the primitive radial symmetry is converted into the bilateral, which is preserved in the adult; the rudiments of the nervous centres are modified to follow this change of symmetry. Two chief centres of proliferation appear in each of the cephalic and medullary plates, and are arranged symmetrically around the new longitudinal axis which divides the body into two halves.

In the primitive types the medullary cords inclose, for the whole of their extent, an equal number of nerve-cells and fibrils, while in the higher types there is a differentiation into ganglia formed of cells only and of connective fibrils. The author cannot regard the phenomenon of the production of the metasoma by the prosoma as similar to an alternation of generation, as does Kleinenberg. Nor, as he will show in a

* Comptes Rendus, cviii. (1889) pp. 359–61.

more extended memoir, can he accept the views of the just-mentioned naturalist or those of Sedgwick as to the relations between Medusæ and Annelids.

Epidermis of Serpulidæ.*—M. A. Soulier has had some difficulty in examining the structure of the epidermis in these worms. The cells are not sharply distinguished, and they vary in the degree to which they stain, while it often happens that they become retracted. Like Claparède he is able to distinguish a true epidermis from a hypodermis; in the former are numerous alveoli, some of which are found empty, while others are filled with granulations or a homogeneous liquid which stains intensely. These alveoli elaborate the mucus; they are surrounded by fibro-cells which stain less intensely. The hypodermis has a similar constitution; in certain cases it increases in thickness and forms swellings. *Myxicola* secretes a very thick tube in a few minutes, owing to the large number of these swellings which it possesses. The author is of opinion that the supporting and the muciferous fibro-cells of the epidermis of the Serpulidæ have their origin in the hypodermis, and that they are merely differentiated connective cells.

Marine Oligochæta of Plymouth.†—Mr. F. E. Beddard states that there are three species of Oligochæta common in the Sound at Plymouth, which are apparently identical with certain forms described by Claparède from the shores of Scotland and France. One belongs to the genus *Pachydrilus*, and the two others are *Clitellio arenarius* and *C. ater*. *Tubifex lineatus* has been stated to occur at Plymouth, but this is a most mysterious species, Hoffmeister's original description not rendering its identification possible.

Australian Earthworms.‡—In his fifth communication on this subject Mr. J. J. Fletcher describes twenty new species of earthworms, chiefly from New South Wales, but there are a few from Queensland and South Australia. They belong to the genera *Megascolides*, *Perissogaster*, *Digaster*, *Perichæta*, and *Cryptodrilus;* of the last there are eleven species. At present it would be premature to separate any as types of new genera, though it is obvious that that will have to be done, so remarkable are the characters of some of the species. Some fifty species of Australian earthworms are now known, but three or four times as many probably remain to be discovered. It cannot yet be certainly said that the interesting morphological points detailed by Prof. Baldwin Spencer in his recent memoir on *Megascolides australis* will be found to be of equal systematic value.

Green Cells in Integument of Aeolosoma tenebrarum.§—Mr. F. E. Beddard describes the green-coloured spots of this worm as large cells with a thin peripheral layer of protoplasm containing a nucleus; in the centre is a large globule of oily appearance impregnated with the colouring matter; treatment with various reagents seems to show that this green pigment is not chlorophyll. The author suggests that it belongs to the class of respiratory pigments, with a number of which he compares it, and it seems also to be of value as a means of protection.

* Comptes Rendus, cviii. (1889) pp. 460–3.
† Journ. Marine Biol. Assoc., i. (1889) pp. 69–71.
‡ Proc. Linn. Soc. N.S.W., iii. (1889) pp. 1521–58.
§ Proc. Zool. Soc., 1889, pp. 51–6 (1 pl.).

Anatomy of Hirudinea.*—Mr. C. O. Whitman has a preliminary notice of some new facts about the Hirudinea. As a group, they are characterized by the possession of segmental organs on the first ring of every somite. The diffuse or non-metameric arrangement which is seen in *Nephelis* and some other forms seems to have been acquired secondarily. The author has shown that in all ten-eyed leeches the eyes represent enlarged, more or less modified, segmental sense-organs; if this be true of other leeches, it would appear that the metameric sense-organs are earlier in origin than the non-metameric. In two species of *Clepsine* it has been seen that the segmental sense-organs appear very early in the embryo, before the time of hatching, while the scattered organs arise later. The labial sense-organs are serially homologous with ventral sense-organs, as the author will soon show. Mr. Whitman's experience leads him to think that "most of our reputed blind leeches will yet be made to bear testimony to the blindness of their observers." In a new Japanese marine leech, *Branchelliopsis*, eyes appear to be altogether wanting, but very careful search revealed the presence of at least two pairs of eyes. They have so little pigment that they cannot be seen from the surface, but the visual cells are there. Another new genus, *Piscicolaria*, from the smaller lakes of Wisconsin, comes nearer to being blind than any leech yet examined; the only evidence of an eye is a single large visual cell on either side of the head without a trace of pigment-investment. The test of a leech eye is the presence of visual cells; these are the large clear cells of Leydig; they always make up the bulk of the eye, and in the *Hirudo* pattern they are the only cells which are supplied by the optic nerve; their main axis is generally, though not invariably, parallel with the axis of the eye; in *Clepsine* and *Branchelliopsis* the nucleus lies on the side exposed to the light, the clear rod-like part of the cell being directed towards the pigment; the cells are practically inverted, the nerve-fibres entering at the nucleated pole. The chief distinction between the different patterns of eye and the typical sense-organ lies in the relative abundance of the clear cells.

The segmental sense-organs are double, both in structure and function; there is an axial cluster of elongated cells, terminating at the surface in minute hairs, and probably representing a tactile organ. Around and beneath the tactile cells are the large clear visual cells, so characteristic of the eye. We have, therefore, a visual and a tactile organ combined, both derived from a common mass of indifferent epidermal cells, and both supplied by fibres from a common nerve-branch. Incredible as the double nature of these organs may at first appear, there is no escape when we once understand the structure of the eye in *Clepsine*. Both the eyes and the segmental sense-organs develope as local thickenings of the epidermis, and at first the cells are alike in form, size, and structure; about the time the pigment begins to appear the two sorts of sense-cells begin to show a difference in size, and an indistinct boundary line appears between them.

It is urged that the metameric arrangement of the sense-organs of the Hirudinea is a matter of more importance than the latest writer on the subject—Apàthy—appears to imagine. The key to the analytical study of the external form is to be found in the metameric disposition

* Journal of Morphology, ii. (1889) pp. 586–99.

of the sense-organs. The terminal somites are of the highest importance for specific diagnosis, and the annular composition, which offers so much of theoretical interest, cannot be deciphered without the use of these organs.

But the importance of the segmental character of the sense-organs is not to be measured by its usefulness in systematic determinations; nowhere is a chapter in the evolution of sense-organs so perfectly preserved as among the Hirudinea. These segmental organs appear to be identical with the lateral-line organs of Vertebrates, and it is suggested that they have formed the starting point for the organs of special sense in the higher animals, not excepting even the eyes of Vertebrates. Mr. Whitman thinks that if we take what are now incontestable facts in the phylogeny of annelid and arthropod sense-organs, and add to them the evidence in favour of the common derivation of the vertebrate organs of special sense, we shall not much longer be able to concede to the visual organs of Vertebrates the position of isolation they have so long held. In the study of this question we must remember that (1) vertebrate sense-organs must be assumed to be derived from invertebrate sense-organs, and the history of the latter must furnish clues to the genesis of the former; (2) in the development of special senses visual cells have made the widest departure from the primitive tactile cells; (3) the medullary plate of the vertebrate is undoubtedly an enormous extension of the ancestral invertebrate plate; (4) sense-organs lying originally outside the neural plate have probably, in consequence of this extension of width, been brought within the medullary area; (5) the ancestral segmental sense-organs were not limited to a single pair of lateral lines, but there were several paired lines arranged symmetrically on the dorso-lateral and ventro-lateral surfaces.

A careful analysis of the annular composition of the body of *Clepsine* has enabled the author to find just twenty-six somites in front of the caudal sucker. Adding seven for the sucker, we have thirty-three, so that the number of somites determined by the external rings agrees precisely with the number of ganglia in the ventral chain.

The nervous system of *Branchelliopsis* is exceptionally interesting from the possession of veritable spinal ganglia; they are lodged in the anterior (sensory) of the two spinal nerves of each somite at a short distance from the ventral cord. A pair of colossal nerve-cells are found between every two consecutive ganglia in the ventral cord of this leech. They contain axial cells which undoubtedly correspond to the neurochord cells of other Annelids and probably to the colossal nerve-fibres of *Amphioxus*, Müller's fibres in *Petromyzon*, and Manthner's fibres in Teleosteans.

In *Clepsine chelydræ* the spinal nerves issue as three distinct roots, the anterior of which unites with the middle to form one nerve. The agreement in form and structure between *Piscicolaria* and the Japanese *Branchelliopsis* is remarkable, for it is much closer than that between the fresh-water *Piscicola* of Europe and marine leeches.

All the Hirudinea may be derived from a form in which the somite consists of three rings; the author promises to explain in an early paper how these rings may become 4, 5, 6, or 12. Copulation in *Clepsine* is never direct, that is, by union of sexual pores; as in *Nephelis* and *Peripatus*, the spermatozoa are transmitted in spermatophores which are planted on any part of the exterior, preferably on the back. The gradual contraction of the sperm-case forces the contents through the skin in a steady stream, which can be seen under a magnifying power of twenty diameters.

Reproductive Organ of Phascolosoma Gouldii.* — Mr. E. A. Andrews has examined the reproductive organs of this Gephyrean. There is a single reproductive organ, made up of a solid mass of germ-cells supported by a structureless lamella projecting horizontally from between the retractor muscle-fibres and the enveloping peritoneal membrane; it is invested by a delicate nucleated membrane. Branches of the supporting lamella extend into the chief lobes of the organ, and are accompanied by elongated nuclei, similar to those of the peritoneal membrane. The germ nuclei have quite different staining properties from these nuclei; they increase in size towards the distal or free ends of the lobes of the organ, where they are surrounded by protoplasm; this acquires definite cell-walls before the cells thus formed break loose from the others into the cœlom. In this last various stages in the growth of the ova, from the naked cells, 24 μ in diameter, to the apparently mature, 185 μ in diameter, were observed. An ovum in which the yolk measures 151 μ had a vitelline membrane 3 μ thick perforated by innumerable pores, through which delicate pseudopodia-like processes pass out into an outer gelatinous case 12 μ thick.

The reproductive organ of *P. Gouldii* is probably to be regarded as a thickened fold of the peritoneum supported by a structureless basement membrane or lamella; the nuclei of the peritoneum multiply rapidly to form a mass of germ nuclei, which, on the surface of the mass, acquire considerable cell-protoplasm; they are then forced out from the ends of finger-like processes into the cœlom by the growth of more deeply lying cells; the investing membranous part of the original peritoneum is ruptured at its ends, when this occurs.

β. Nemathelminthes.

Coffee-Nematode of Brazil.†—Dr. E. A. Goldi has a note on *Meloidogyne exigua*, the nematode which has for nearly twenty years been the cause of disease in the coffee-plantations of Brazil. The females are found to form cysts in swellings on the plants, and their vegetative organs are reduced, while their ovary is so swollen as to make the recognition of the vermian nature of the formless sack a matter of difficulty. The ova, which are 0·085 mm. long, have a transparent, thick and resisting membrane. The young are transparent, colourless, and cylindrical, the aboral end being drawn out to a long, fine point; at the terminal end of the œsophagus there is a spherical, muscular swelling. The adults are more club-shaped in form, the aboral end being thicker than the oral, and ending in a sharp spine. A great deal remains to be discovered with regard to the discrimination of the sexes, the manner in which encystation is effected, and the wanderings of the young.

Physaloptera.‡—Prof. M. Stossich gives an account of the general characters, the constituent species, and the distribution of the Nematode genus *Physaloptera* Rudolphi. Twenty-eight certain species already recorded are diagnosed, and notice is taken of nine others insufficiently

* Zool. Anzeig., xii. (1889) pp. 140–2. † Zool. Jahrb., iv. (1889) pp. 262–7.
‡ Bull. Soc. Adriat. Sci. Nat., xi. (1889) pp. 36–59 (3 pls.).

known. The hosts comprise over a hundred reptiles, birds, and mammals.

Female Genital Ducts of Acanthocephala.*—Herr P. Knüpffer corroborates the observations of Saefftigen on this subject. Independently of the latter, he demonstrated that the oviduct, described by Leuckart as single, is really double. The muscular structure or "Glocke" which receives the embryos from the body-cavity, the double ducts which are continuous with the former, the so-called "uterus" in which the ducts merge, the muscular and glandular terminal portion or "vagina," are described and figured. Knüpffer's researches included *Echinorhyncus hæruca* Rud., *E. polymorphus* Bremser, *E. globulosus* Rud., *E. strumosus* Rud., *E. pseudosegmentatus* n. sp., which are all separately discussed. The author contributes some notes on the body-wall and the musculature, and denies the legitimacy of the genus *Paradoxites*, which Lindemann sought to establish as distinct.

γ. Platyhelminthes.

Gunda ulvæ.†—Herr A. Wendt is of opinion that the *Planaria ulvæ* of Oersted should be placed in the genus *Gunda*; the chief cause for this change lies in the close resemblance exhibited by the terminal organs of its generative apparatus to that of *G. segmentata*; the course taken by the oviducts, their union, and the opening of the unpaired oviduct into the uterine duct. In most fresh-water Planarians the uterus lies between the pharyngeal pouch and the penis, but in *Gunda* the penis is near the pharynx and the uterus is placed further back. Close similarity is also to be detected in the arrangement of the central nervous system.

On the other hand, the gonads do not in *G. ulvæ* exhibit the same marked segmental arrangement as in *G. segmentata*; before, however, judgment is passed on this point a larger number of marine Planarians must be examined.

Nervous System of Nemertines.‡—Herr O. Bürger has a preliminary communication on the nervous system of Nemertines. On the whole he confirms the observations of Hubrecht. He has succeeded in discovering an anal commissure of the lateral nerves in *Cerebratulus*. The œsophageal nerve-trunks (vagus of Hubrecht) of that worm, of *Langia*, and of *Polia* are connected by a strong commissure, which contains ganglionic cells. The proboscis of Schizo- and Palæo-nemertinea is innervated by two ascending nerves given off from the ventral ganglion, which form a layer around a muscular zone. In the Hoplonemertinea ten to seventeen cords enter the proboscis, where their course is constant; they are connected by transverse fibrous bands, which separate the longitudinal musculature into two concentric layers. In the body there is an inner layer between the circular and internal longitudinal musculature, in addition to the peripheral nervous layer. Besides the already known sensory organs, the author found an altogether terminal epithelial invagination on the head, to which a nerve passes. The lateral cephalic pits of the Hoplonemertinea are provided with sensory cells which carry rods.

* Mém. Acad. Imp. Sci. St. Pétersb., xxxvi. (1888) pp. 18 (2 pls.).
† Arch. f. Naturgesch., liv. (1889) pp. 252–74 (2 pls.).
‡ Nachr. K. Gesell. Wiss. Göttingen, 1888, pp. 479–82.

The histological characters of the central nervous system have been specially investigated; it contains ganglionic cells and fibrillar substance, and a highly differentiated connective tissue. All the ganglionic cells are unipolar and devoid of membrane, and lie in sheaths of connective tissue. They are (1) cells with poorly developed body, darkly coloured, highly refractive nuclei, small and irregular in form; or (2) small, elongated, club-shaped cells, with oval nuclei and one or more nucleoli; or (3) they are large, lightly coloured, flask-shaped, with large round nucleus and one nucleolus; or (4) they are colossal cells, which quickly take up colouring matters, and have a round nucleus with a projecting, large nucleolus.

The connective tissue is of two types; one is like the neurilemma, while the other consists of fibres which are given off from numerous, dendritically-branched processes of membraneless cells; they surround in large numbers the ganglionic cells, and may be easily recognized by their large oval nucleus and their peripheral zone of granules.

Helminthological Notes.*—Dr. von Linstow has another of his papers on new and imperfectly known worms. He has made an examination of the internal structure of *Pseudalius minor*, taken from various organs in the common Porpoise. *Physaloptera præputialis* sp. n. was found in Brazil in *Felis catus;* it is chiefly remarkable for the præputium-like duplication of the skin at the caudal end of the body in both sexes. *Tr. campanula* sp. n. is from the domestic cat of Brazil; it is possible that this is the same as the form which Diesing named *Tr. felis*, but did not describe.

Echinorhyncus Dipsadis sp. n. was found represented by fifteen examples in the enteric wall of a large *Dipsas Blaudingi* from the Cameroons, where it lived in its larval condition; encapsuled *Echinorhyncus*-larvæ have been found in a number of snakes; their adult forms are probably to be sought for in birds of prey.

Cercaria terricola sp. n. was found in the liver of *Helix* ? *vermiculata* from Algiers, and *C. terrestris* sp. n. from the same organ in *H. lens* from Greece. The author concludes with some remarks on the anatomy of *Bothriocephalus rugosus;* this species may be as much as 380 mm. long. The muscles of the parenchyma are well developed, but those of the subcuticular layer are very feeble. Of the former the longitudinal muscles are the best developed. The nervous system consists of two ganglia connected by a strong transverse commissure, and of two strong longitudinal nerves invested in a sheath. Outside the nerve-trunks there are ten vascular trunks, which are 0·016 mm. broad. On the whole, this species of *Bothriocephalus* is very different from *B. latus*, and recalls rather the *Tæniæ* of Birds.

Herr G. Brandes † gives an account of a very small *Distomum* (*D. claviforme* sp. n.) which he found in large numbers in the rectum of *Tringa alpina*. Its body is divided into a longer flat anterior portion and a shorter spherical hinder part; the latter contains the generative apparatus. Another new species was found in the small intestine of the frog; it is 2·5 mm. long, and it is to be called *D. turgidum*. The author concludes with some notes on *D. heteroporum* from *Vespertilio pipistrellus*, which seems to have been somewhat misunderstood by Van Beneden.

* Arch. f. Naturgesch., liv. (1889) pp. 235–46 (1 pl.).
† T. c., pp. 247–51 (1 pl.).

Prof. M. Stossich * continues his helminthological researches, describing seven new species of *Distomum*, of which six are figured. Several other species of *Distomum* are discussed, and the occurrence of some other parasites (*Tænia botrioplitis*, *Ascaris ensicaudata*, &c.) is recorded.

The Species of Distomum in Amphibians.†—Prof. M. Stossich describes 16 species of *Distomum* parasitic in Amphibians, and seven others somewhat doubtful. A list of 24 Amphibian hosts with their known *Distomum* parasites is furnished; in *Rana temporaria* nine species occur, in *R. esculenta* ten.

Anatomy of Phylline Hendorfii.‡—Dr. von Linstow gives an account of the anatomy of this new species of ectoparasitic Trematode, which was found on the scales of *Coryphæna hippurus*. The body is ovate in form, 8·7 mm. long, and 5·2 mm. broad; at the anterior end there are two suckers, and at the hinder end one which is very large. The former are attached to the body in such a way that their hinder and lateral margins are free; the latter, which is 3·1 mm. broad, carries three pairs of hooks; there are two stiff supporting lamellæ, which obviously prevent the suckers from being torn off. All the three sucking discs consist of a cuticle, which is much stronger on the dorsal than on the ventral surface, and of a well-developed dorsoventral muscular mass, in which separate cells are imbedded; the parenchyma is feebly developed, is fibrous, and contains no nuclei. The three pairs of hooks vary a good deal in structure; the most anterior pair is surrounded by two tendons which lie in a sheath where they can work backwards and forwards. While the hooks of most Trematodes and Cestodes are organs which serve for attachment, those of this form are clearly organs which are adapted to loose the parasite from its place of attachment; the median long hooks have the function of surrounding the free margin of a fish's scale. These hooks are of a horny nature

The cuticle consists of a plexiform fundamental tissue, the spaces in which are filled by rods of various sizes, better developed on the dorsal than on the ventral surface, and giving a villous appearance. In the dorsal cuticle there are also numerous rounded glands, which probably secrete mucus. The muscles of the cortical layer must be distinguished from those of the parenchyma; they are either longitudinal, circular, or diagonal in direction. The muscles of the parenchyma are uncommonly strong, and are remarkable for passing through the testes, ovary, and shell-gland.

The mouth is a large, almost spherical organ, 0·78 mm. in diameter; while it is well developed, the intestine is very feeble, and we must suppose, therefore, that the ingestion of food requires much greater strength than its propulsion and absorption. A rich vascular system traverses the whole body; it is formed of two large longitudinal trunks which divide the body into three nearly equal thirds; posteriorly they unite to form a cylindrical pulsatory vesicle which is covered by the posterior sucking disc, and opens by a foramen caudale. Anteriorly they widen out into large vesicles which vary considerably in their condition of contraction; one is almost always much larger than the other, and both

* Boll. Soc. Adriat. Sci. Nat., xi. (1889) pp. 23–30 (2 pls.).
† T. c., pp. 60–74.
‡ Archiv f. Mikr. Anat., xxxiii. (1889) pp. 163–80 (2 pls.).

open by a small cleft outwards. Secondary are given off from the primary trunks, and all the trunks form anastomoses with one another.

The brain has the form of a kidney-shaped group of ganglionic cells which lies just above the mouth; four ocelli may be noticed in it; a second group of cells lying just behind the mouth may be called the œsophageal ganglion. Four to six nerves are given off anteriorly from the brain; four nerves run along the ventral surface of the body; these nerves are easily recognized in stained transverse sections of the body; a third pair of nerves, which are much thinner, are placed on the dorsal surface. In the middle of the brain lie four ocelli; each of these consists of a spherical lens surrounded by a layer of pigment; on the free side of each is a small highly refractive spherule which, possibly, acts like the condenser of a Microscope. These ocelli are remarkable for lying not in the cuticle, but in the centre of the brain, so that they are covered externally by a layer 0·14 mm. thick. It seems clear, therefore, that they cannot have the function of recognizing images, but can only be able to distinguish light from darkness, as is the case with the eyes of various Vertebrates which are covered by the skin.

The body-parenchyma, which stains feebly, is not cellular in structure, but consists of a fine fibrous ground-substance, in which are rounded or angular nuclei, 0·02 mm. in size. There is one ovary, and a pair of testicles; the seminal vesicle has very strong walls; the cirrus is large and spindle-shaped, and lies to the left of, and just beneath the mouth. The ovary is rounded, and is placed just in front of the testes; superficially the two organs are very much alike. The vitellaria are very widely distributed in the body, and lie in a dorsal and a ventral plane; the ootyp is spindle-shaped, and in it there is always found only one egg. The shell-gland is of great extent, and consists of a large number of pyriform glands with long efferent ducts. The ova are rhomboidal, irregular, or triangular in form; at the hinder end there is a filamentar appendage of varying length. There is no canal of Laurer; a comparison of various forms shows that by this term, organs of various functions are spoken of. Like the two other species of *Phylline*, the development of *P. Hendorfii* is unknown; it is doubtless monogenetic, and its embryos swim about in water by the aid of an investment of cilia.

The author points out the differences between the three species, and concludes with enumerating the generic characters of *Phylline*.

Nervous System of Amphiptyches.*—Dr. F. S. Monticelli has, in the course of his researches on *Amphiptyches*, elucidated the nature of the nervous system, which has hitherto been known only through a brief notice by Wagener. It consists essentially of two lateral ganglionic swellings, situated in the anterior portion of the body, and united by a transverse commissure. Four nerves, two anterior and two posterior, rise from the two ganglionic swellings. The whole system, of which the details are described, lies rather towards the ventral surface. Morphologically the system agrees with the general cestode type, and closely resembles that of the simpler Cestodes, especially that described by Lang in *Amphilina foliacea* Wagen.

Cercaria setifera.†—Dr. F. S. Monticelli has a preliminary notice on a *Cercaria* with a long tail and lateral bristles, which occurs in the

* Zool. Anzeig., xii. (1889) pp. 142–4.

† Bol. Soc. Nat. Napoli, ii. (1888) pp. 193–9.

Gulf of Naples, sometimes free-swimming, but more frequently on pelagic Cœlenterates, Tunicates, worms, and molluscs. He identifies it with *Cercaria setifera* Müller and with the *Cercaria echinocerca* of de Filippi, and considers it as not improbably related to a form of *Distomum* found in *Beroë*. The characteristics of the species are shortly described.

Structure of Solenophorus.*—Signor C. Crety has particularly devoted himself to the nervous system of *S. megacephalus*, in regard to which the results of Moniez, Roboz, and Griesbach are not in agreement. Two longitudinal nerves extend down the body; these are united in a commissure and ganglionic centre in the head. The histology is discussed, and the entire system regarded as closely resembling that of *Bothriocephalus latus* as described by Niemiec.

δ. Incertæ Sedis.

Rotifers Parasitic in Sphagnum.†—Mr. W. Milne describes two species of Rotifers found living inside the cells of *Sphagnum*, and thus confirms observations made nearly forty years ago by Roeper and Morren. These observers supposed the animal they saw to be *Rotifer vulgaris*, but Mr. Milne designates what he observed as *Macrotrachela roeperi* sp. n. and *M. reclusa* sp. n. In three different gatherings of the *Sphagnum*, at considerable intervals of time, from the same locality, both species were found abundantly. The observer believes the distribution of the rotifers in the *Sphagnum* to be mainly effected by the external openings in the cells, yet one of the forms observed forcing its way out took two or three minutes to escape through the opening. In one case, two adults and an egg were seen in the same cell, which was possibly the result of a breakage between two adjacent cells. There is of course no real parasitism, but the shelter afforded is doubtless advantageous.

American Rotifera.‡—Dr. D. S. Kellicott gives a partial list of the Rotifera of Shiawassee river at Corunna, Michigan. From the brief examination he was able to make, he was led to the conclusion that the rotiferal fauna of inland America is abundant, and that the species are largely identical with those of Europe, even to a greater degree than in the case of Infusoria. The author adopts the classification of Hudson and Gosse.

The new forms described are:—(1) *Limnias shiawasseënsis*; it has very much longer antennæ then *L. annulatus*, and has different horny processes and tube; (2) *Œcistes mucicola*, which dwells in tubes made in the mucilaginous matrix of the common Alga *Gloiotricha pisum*; (3) *Callidina socialis*, found parasitic on the larva of the beetle *Psephenus Lecontei*, has a corona which is relatively wider than that of *C. parasitica*, and its antenna does not end in three lobes; and (4) *Sacculus hyalinus* which is much smaller then *S. viridis*. In all, fifty species are enumerated in this list, so the percentage of new forms is very small.

Tornaria in British Seas.§—Mr. G. C. Bourne gives an account of the well-known pelagic larva of *Balanoglossus*, which was for the first

* Boll. Soc. Nat. Napoli, ii. (1888) pp. 124–30.
† Proc. Phil. Soc. Glasgow, 1889, 6 pp. (1 pl.).
‡ Proc. Amer. Soc. Micr., x. (1888) pp. 84–96.
§ Journ. Marine Biol. Assoc., i. (1889) pp. 63–8 (2 pls.).

time found last year in British Seas. Its discoverer was Mr. Weldon, who was working at the Plymouth Laboratory.

The smallest larvæ were 0·33 mm. in length, and it would seem that the posterior division of the gut is not a proctodœum, but that the blastopore persists as the anus without being pushed further inwards by a secondary invagination of ectoderm. In later stages all the characters of a *Tornaria* were found exhibited. The anterior body, which is probably formed from the amœboid cells found in the earlier larva, is connected by a muscular thread with the now conspicuous apical sense-organ. A perfect *Tornaria* was as much as a millimetre in length, but individuals vary greatly in this respect. Each ciliated cell is long and columnar, slightly contracted in the middle of its length, and has a large nucleus; the cilia can be traced as fine fibrillæ inwards as far as the nucleus, but the author was unable to determine whether or no they entered it. The "heart," as some authors call it, appears as a vesicle lying just above and to one side of the proboscis pore.

The central portion of the apical sense-organ is composed of columnar sense-cells bearing cilia; on it there are larger cells surrounding a pair of deeply pigmented pits—the eye-spots of previous authors. Beneath the sensory cells is a thin layer of nerve-fibres.

Specimens of the larvæ at later stages were never found, and it is very probable that *Tornaria* ceases to lead a pelagic life, sinks to the bottom, and undergoes its further development there.

Echinodermata.

Ludwig's Echinodermata.*—Prof. H. Ludwig has issued another part of his work; the description of the calcareous bodies is continued and completed. The general ground-form of these bodies is, in the Dendrochirota, derived from an X-shaped rudiment, which has been developed by the forking of the ends of a short rod. The same is true of the "stools" of the Aspidochirota, and the four-armed calcareous bodies of the Elasipoda and some Aspidochirota, as well as of the fenestrated plates of the Molpadidæ, and the anchor-plates of the Synaptidæ. The anchors of these last may be referable to the same scheme, but the "wheels" are more difficult to explain. Another kind of calcareous body which is difficult to explain are the "tables" of the Aspidochirota, which are symmetrically perforated, though there can be little doubt but that they will be found to be derived from the bifurcating rod. The angle at which this forking takes place is, as a rule, 120 degrees. The concentrically striated bodies which are found in *Trochostoma* and *Ankyroderma* appear to be special bodies, agreeing only with the rest in that they consist of an inorganic substance.

The musculature of the body-wall and the histological characters of muscle are next considered. In dealing with the nervous system Prof. Ludwig gives a diagram to show the relations of the parts. The central nervous system consists of a circular and of radial nerves. The peripheral nerves derived from the former of these are the tentacular, the integumentary nerves of the oral disc, and that of the pharynx; with the last the plexus on the stomach and on the small intestine may be connected. The peripheral nerves derived from the radial are those of the

* Bronn's Klassen u. Ordnungen, ii. 3. Echinodermata, by Dr. H. Ludwig, Leipzig and Heidelberg, 1889, pp. 49–80 (pls. 1–5).

foot-suckers, of the skin, of the muscles, of the nerves to the closing musculature of the cloaca, and of those to the mesentery of the hinder end of the body. In the third place there are sensory or terminal organs. The tentacular nerves serve the sensory plates of the tentacles of the Aspido- and Dendrochirota, the bud-like sensory organs, and the tactile papillæ of the tentacles of the Synaptidæ. The sensory cells of the skin are innervated by the tegumentary nerves; those of the foot-suckers and ambulacral papillæ by the nerves that go to them, while the tegumentary nerves supply the tactile papillæ of the skin of the Synaptidæ and the sensory cells of the skin. When auditory vesicles are present the radial nerves give off auditory trunks.

Anatomy of Ophiuroids and Crinoids.*—Dr. O. Hamann continues his account of the morphology of Echinoderms by treating of the anatomy of Ophiuroids and Crinoids. In summarizing his results generally he commences with the ambulacral nervous system; this is found in all Echinoderms, lying, in Asterids and Crinoids, always in the ectoderm, and in others in the cutis, where it is generally surrounded by schizocœl spaces. In Crinoids the œsophageal ring is lost. The facts that the ambulacral nerve-trunks of Ophiuroids are jointed, and that there are ganglia in the dorsal as well as the ventral cells, are of great importance. The ambulacral and mesodermal nervous system of the Crinoids and its origin are next considered. This system consists of a mesodermal pentagonal nerve-ring, and, in each arm, of two longitudinal nerves, and the question arises, did these parts arise separately or is their present condition a secondary one? The oral-mesodermal portion is regarded as being derived from the ambulacral nervous system of Crinoids, support for this view being found in the fact that the latter is only preserved in rudiment in the epithelium; this ambulacral system has no central organ, and the nerves in the epithelium are very poorly developed as compared with the homologous nerves of other Echinoderms. The ectodermal portion, therefore, has passed from the ectoderm into the mesoderm, and its branches have been developed in the same way as the peculiar nerves of Ophiurids, which arise at definite intervals from the ambulacral nerves and form intervertebral nerve-branches. But while the latter have retained connection with their point of origin, they have lost it in the Crinoids. Further evidence in support of this view is given by the agreement in structure which the three parts present. In all three there are the same nerve-fibrils and ganglionic cells. While there is no direct connection between the epithelial, ambulacral nervous system and the other parts, there is such between the dorsal and ventral portions.

The peripheral nervous system and the sensory organs are next considered; in the Crinoids there are nerve-endings in the epithelium of the skin similar to those found in Asterids and Holothurians, as also the sensory buds on the tentacles, which have been recognized by Jickeli as sense-organs. In the Ophiurids, as the physiological investigations of Preyer have conclusively shown, the peripheral nervous system is exceedingly well developed; special sensory organs may be found in large numbers on the tentacles of *Ophiothrix*, and the nerve-endings in the epithelium are similar to those of Crinoids. In all groups there is a nervous system in the epithelium of the enteric tract.

* Jenaische Zeitschr. f. Naturwiss., xxiii. (1889) pp. 233–388 (12 pls.).

The water-vascular system has a similar character in all groups, but the Crinoids have no madreporite, and their pore-canals do not open directly into the stone-canal, but into superficially placed cavities of the enterocœl. The valvular arrangements of this system are of great interest, but they are wanting in Ophiuroids and Crinoids, where they are replaced by transversely disposed muscular fibres which traverse the lumen of the vessels.

All the groups are provided with genital tubes; in Crinoids they are placed in the arms, in Ophiuroids in the dorsal wall and in the walls of the bursæ, and in Asteroids and Echinoids in the dorsal wall of the disc. The several groups present differences in the place of maturation of the primordial germ-cells, for in Crinoids they ripen in the pinnules, and in Ophiurids on the walls of the bursæ.

In addition to smooth and transversely striated muscular fibres, there are in Ophiuroids peculiar obliquely striated fibres. Epithelio-muscular cells have been found in Holothurians, Asteroids, and Crinoids. The musculature is partly of epithelial and partly of mesenchymatous origin. The Crinoids are remarkable for spindle-shaped muscular fibres, which are found in the arms as well as in the pinnules and cirri.

The glandular organ or so-called heart is not the central organ of the blood-lacuna-system; muscular fibres are never found in its walls. It is impossible to say at present what the function of this organ is; the only thing which can be said with certainty is that the organ has a glandular structure. The connection between it and the genital tubes, which is to be seen in Asteroids and Crinoids, is of significance.

With regard to the structures of the schizocœl, it is to be noted that there is a very well developed cavitary system in Asteroids which has the form of clefts and spaces in the connective substance; in the Ophiuroids they are less extensive, and in the Crinoids they are represented by the longitudinal canals which lie beneath the ambulacral nerves.

The author's determination to deal with the phylogeny of the Echinodermata has wavered as his work proceeded, for he has been led to see of how subjective a nature such a representation is. Of one point only is he firmly convinced, and that is, the Asterids are connected with the Echinids, and that the latter may be derived from the former. The Holothurians appear to be forms which have undergone degeneration; many characters speak to their derivation from Echinids; the Crinoids seem to be the most highly organized forms, and with the Ophiuroids form a group which have no specially close relation to the others, save that they are all derived from an ancestor in which a water-vascular system, a cœlom, an ectodermal nervous system and definite calcareous plates were already developed. With regard to Semon's recent attempt to map out the phylogeny of the group, Dr. Hamann remarks that, in the present state of our knowledge of the development of Echinoderms, it is too early to speak definitely of a Pentactula-stage of a Pentactæa; nor does he think it correct to say that there is such a stage in all groups, for the structures which have been spoken of as one and the same stage are different, and show undoubted modifications. Further objections are raised to the views of Semon, and it is, in conclusion, suggested that weight should still be attached to the homologies of the calcareous plates.

Nervous System of Ophiurids.*—Dr. C. F. Jickeli has extended his observations on the nervous system of Echinoderms to Ophiurids. If a number of sections of an arm be examined, four nervous systems will be found extending in a longitudinal direction—there is the ambulacral nerve of authors, which Dr. Jickeli proposes to speak of as the ventral radial system; placed on this, and separated from it by a structureless lamella, is the paired ganglionic chain of Lange which it is proposed to call the median radial system; on the dorsal wall of the perihæmal canal is a paired ganglionic chain, which may be distinguished as the dorsal radial system. Two ganglionic chains lie between the dorsal and ventral muscle on the external edge of the ambulacral plate; this is the lateral radial system.

The ventral radial system gives off on either side a nerve which passes up the wall of the perihæmal canal, and fuses with the neighbouring cord of the dorsal radial system; a branch on either side, which is continued laterally, gives off a branch into the muscle between the adambulacral and basal plate, and breaks up within the former into several branches; of these the innermost passes to the dorsal plate, while the other branches enter an adambulacral papilla; this may be called the adambulacral nerve. Belonging also to the ventral radial system is a nerve on either side for the ambulacral pedicels; this forms a subepithelial sheath around the whole pedicle, and becomes consolidated on its adoral side into a strong cord which is circular in transverse section.

The median radial system gives off a branch on either side which innervates the ventral interambulacral muscle, and another which, like it, arises from a ganglion, and innervates the dorsal interambulacral muscle. The dorsal radial system gives off branches on either side, one of which ends in a ganglion of the lateral radial system, another which becomes connected with the nerve for the ventral intervertebral muscle, and others which unite with the dorsal. The three pairs of ganglia of the dorsal radial system are connected by transverse commissures, but the author could not find the one described by Lange.

In all, each ambulacral segment has nine pairs of nerves; in the formation of the oral ring, the ventral, median, and dorsal radial systems take part, and this therefore consists of three different rings. In addition to these, another is formed by the lateral system; as it lies more externally than the others, it may be called the outer oral ring, while the oral ring of previous authors is to be called the inner oral ring. From this last the ventral ring gives off branches to each of the two oral pedicels, and a strong branch, which, in its somewhat complex course, gives off a number of branches; all these are connected with the corresponding branches of the adjoining rays. With them the bifurcate branches of a third trunk become connected. The median and dorsal rings combine to give a trunk which sends nerves to the adoral side of the outer interradial muscle. Branches are given off dorsally from the dorsal nerve-ring which appear to innervate the water-vascular ring and the Polian vesicles. Strong nerves are given off at regular distances to the "lips"; these appear to be processes from all the three systems which compose the inner oral ring. No indications were seen of the

* Zool. Anzeig., xii. (1889) pp. 213-8.

subepithelial enteric plexus, which has been made out by the author in Crinoids and Asteroids.

Morphology of Crinoids.*—Dr. O. Hamann, in a preliminary communication, deals with the nervous system of Crinoids. The epithelial portion consists of the subepithelial plexus described by Ludwig and others, and of the central œsophageal ring; it corresponds to the œsophageal ring and ambulacral nerves of other recent Echinoderms, which are partly epithelial and partly mesodermal in position. In Crinoids the epithelium of the ambulacral grooves is considerably thickened, and consists of the same elements as in a starfish. In both there are epithelial nerve-fibres with bi- and multipolar ganglionic cells; they have not lost their connection with the epithelium of the body; this nervous system has no central ring. The epithelium of the grooves is made up of sensory and supporting cells, and the processes of the latter traverse the nerve-fibrous ring vertically. In each tentacle there is a nervous band which innervates the sensory papillæ.

Another system of nerves is placed in the connective substance, and to this belongs the fibrous mass placed around the chambered organ with its nerve-trunks, which run along the dorsal side of the arm. Another part of it is ventral in position, and has its own central organ. The two portions of this mesodermal nervous system are connected with one another. The ventral or oral part is divisible into a central organ, an œsophageal ring, and the nerves given off from it; some of these nerve-trunks have been described by Carpenter as a periambulacral network. The nerve-fibrils of the ring have a concentric course, and the number of nerves given off is very large. Some of these take a dorsal or aboral direction and branch in the mesenteries and bands of the cœlom, and on the organs that lie therein. Other nerves pass into the circumoral tentacles. Those that are of the greatest interest are those which enter into definite relations with the water-vessels; these are, at first, five, and they bifurcate and pass into the oral body-wall of the arms. Each water-vessel is accompanied on either side by a nerve-trunk, so that they are twenty nerve-bands in the ten arms, to the tips of which they may be traced. They likewise pass with the branches of the water-vessels into the pinnulæ.

The dorsal or aboral portion of the mesodermal nervous system has likewise a central organ, and the course of the fibres which compose it is complicated. It gives off solid nerve-trunks into the arms, and never hollow tubes as some observers have asserted. The trunks in the arms give off branches from four opposite points; some of these go to the flexor muscles, and others, after much branching, to the dorsal epithelium. Between every two groups of muscles, nerves pass out which go almost directly to the oral body-wall, where they become connected with the oral pair of longitudinal nerves which belong to the oral part of this mesodermal nervous system.

Both the epithelially and mesodermally placed systems are composed of very fine fibres, which generally run parallel and in cross section appear dotted, and of ganglionic cells of various types. The nerves of the cirri are regarded as special nerves; they are the only vascular nerves found in Crinoids.

In addition to the sensory papillæ of the skin there are nerve-end-

* Nachr. K. Gesell. Wiss. Göttingen, 1888, pp. 127-31.

organs scattered over the whole surface of the arms and disc; these are made up of epithelial groove-cells.

The author regards the presence of two nervous systems as, in conjunction with the other structural characters of Crinoids, indicating that this is the most highly developed group of Echinoderms.

Large Starfish.*—Prof. F. Jeffrey Bell describes a remarkably large specimen of *Luidia Savignii* from Mauritius, which has nine arms, none of which are injured or bear signs of having been repaired during life. The disc is 95 mm. in diameter, and the longest arms measure 370 mm., and the shortest 350 mm., so that the span is about 27 inches.

Variation in Ophiura panamensis and O. teres.†—Mr. J. E. Ives has an interesting note on the variations exhibited by examples of these two Ophiurids; *O. panamensis* exhibits a very great variety of colour pattern, due probably to the wide range of the species; the darker varieties are found in the more northern parts of its area of distribution.

Cœlenterata.

Pennatulida of Mergui Archipelago.‡—Prof. A. Milnes Marshall and Dr. G. H. Fowler report on the Pennatulids collected by Dr. J. Anderson. Representatives of five genera and ten species, of the latter of which two are new, were obtained. The numerous examples of both *Pteroeides Lacazii* and *P. chinense* exhibit great variability, and in each case these may be arranged in two groups; the same is true, also, of *P. esperi*. *Virgularia Rumphii* has colonies which may be as much as 900 mm. long; the swelling at the end of the stalk is shown to depend on the state of contraction of the individual and is a character of no practical value in classification. Fifteen specimens of this genus are referred to a new species which is called *V. prolifera;* all show the truncation of the upper end of the rachis that is so characteristic a feature of the genus. The other new species in the collection—*Policella tenuis*—was represented by a single example 252 mm. in length; it can easily be distinguished from *P. maxillaris* which was collected with it.

Lebrunia neglecta.§—Prof. J. P. M'Murrick has a note on this incompletely known Actiniarian. Its original describers, Duchassaing and Michelotti, were wrong in saying that it has five dichotomously branched processes, for it has six; these are, to use the recent nomenclature of R. Hertwig, pseudotentacles. Allied to this form are, apparently, the deep-sea Actiniæ, *Ophiodiscus annulatus* and *O. sulcatus*, described by Hertwig from the 'Challenger' collections, but they are not congeneric. This is proved by the absence in *Lebrunia* of a circular muscle and of specialized gonophoric mesenteries. It belongs to Hertwig's tribe Hexactiniæ, the three divisions of which formed by Andres appear to be natural; to these the author proposes to add a fourth which he calls Dendromelinæ. It would include *Lebrunia* and probably *Ophiodiscus*, and may be characterized by the presence of marginal tentacles arranged in cycles, and by the possession of pseudotentacles arising from the column-wall. Further details are promised.

* Ann. and Mag. Nat. Hist., iii. (1889) pp. 422–3.
† Proc. Acad. Nat. Sci. Philad., 1889, pp. 76–7.
‡ Journ. Linn. Soc. Lond., xxi. (1889) pp. 267–86 (2 pls.).
§ Zool. Anzeig., xii. (1889) pp. 38–40.

Remarkable Actinian.*—Dr. C. P. Sluiter corrects an error which he committed in an article on two remarkable Gephyrea in vol. xlviii. (p. 233) of the Nat. Tijdschr. voor Nederl. Indië. He now sees that *Diphthera octoplax* is an Actinian. He urges that he had never before seen an Actinian of the kind, and that no one who saw it alive would hesitate to call it one of the Phascolosomata. The anterior end of the body looks like a proboscis and acts energetically and not slowly. The histological characters of the integument are much like those of a Sipunculid. The creature should, apparently, be placed in the genus *Edwardsia*.

Caryophyllia rugosa.†—Herr G. v. Koch has made an examination of the structure of *Caryophyllia rugosa*. This form has especial interest from the fact that it was described by Moseley as having the septa arranged in octameral fashion. With this Herr v. Koch cannot agree, as he finds that there are at first six septa of the first order, which are followed by six of the second. Both of these sets are arranged quite symmetrically. When the septa of the third order appear there is some irregularity, for those in two adjoining sections appear earlier than those in the rest, while, at the same time, the interjacent septa of the second order grow more rapidly than their homologues in the four other sectors. There are thus gradually developed eight larger septa (six of the first and two of the second order), and eight smaller septa (four of the second and four of the third order), so that the coral comes to look as though it were octamerous. When the third cycle is complete, the number of septa is again of the hexameral type, but soon afterwards eight septa of the fourth order appear in the already mentioned two sectors. The whole number is thus raised to thirty-two, and as this is not increased the octameral type again becomes apparent. We have here, therefore, an interesting example of a coral which, when adult, is regularly octamerous, being in its youth six-rayed.

Semæostomatous and Rhizostomatous Medusæ.‡—Dr. E. Vanhöffen describes the Medusæ of these orders collected on the 'Vettor Pisani' expedition. Of Semæostomata, six new species are described—*Pelagia neglecta*, *P. crassa*, *P. minuta*, *Chrysaora chinensis*, *Desmonema chierchiana*, and *Aurelia dubia*; seven others are revised; and a systematic review is taken of all the known species in the above genera. Of Rhizostomata, six new forms were discovered—*Cassiopeia picta* n. sp., *Loborhiza ornatella* g. et sp. n., *Stomolophus chunii* n. sp., *Rhizostoma hispidum* n. sp., *Mastigias orsini* n. sp., and *Desmostoma gracile* g. et sp. n. After describing these forms, the author takes a systematic survey of known Rhizostomata. The third part of his memoir is devoted to a survey of the geographical distribution with which a map is given. The two orders differ greatly in their range. Thus in the Red Sea, Semæostomata are absent, but Rhizostomata are abundant; on the Pacific coast of North America the reverse is true. From similar facts Dr. Vanhöffen concludes that the Rhizostomata usually prefer warmer waters, while the Semæostomata are more abundantly represented in temperate zones.

Siphonophora of Canary Islands.§—Prof. C. Chun reports that he has discovered a considerable number of new species of Siphonophora off

* Zool. Anzeig., xii. (1889) pp. 47–8. † Morphol. Jahrb., xv. (1889) pp. 10–20.
‡ Bibliotheca Zool. (Leuckart and Chun), Heft 3 (1889) 52 pp., 6 pls. and map.
§ SB. K. Akad. Wiss. Berlin, 1888, pp. 1141–73. Ann. and Mag. Nat. Hist., iii. (1889) pp. 214–46.

the Canary Islands. Some of them are interesting because of their peculiarities of structure, and others because they are forms which unite groups which hitherto appeared to be isolated. Before commencing the detailed account of the species which he observed, Prof. Chun makes some remarks on the recently published views of Prof. Haeckel.

With regard to the proposed division of the Siphonophora into two subclasses, Prof. Chun urges that Haeckel has founded his speculations on two larval forms of very different morphological value. The Velellidæ certainly represent not only the most complicated in structure, but also the most divergent of the Physophoridæ; but there is no feature in their organization which cannot be explained by gradual adaptation to an existence at the surface of the sea. The author would propose to divide the order Physophoridæ into two suborders, one of which would include all with an unchambered pneumatophore functioning as a gas-gland (*Haplophysæ*), while in the other there would be the (partially) air-breathing Velellidæ (*Trachophysæ*) with a chambered pneumatophore, stigmata, and tracheæ. Prof. Chun also urges reasons against Haeckel's Medusa-theory of the morphology of the Siphonophora.

Among the new forms described are *Doramasia* g. n. for *Ersæa Bojani* Esch., and *D. picta* sp. n.; in it the nectocalyx is diphyidiform, slender, with a long apex to the subumbrella drawn out in the form of a tube, and the Eudoxiæ have special nectocalyces; in *Halopyramis* g. n. the nectocalyx forms a broad, four-sided, tetragonal pyramid, the hydrœcium is infundibuliform, with a projecting denticulate margin, the oil-receptacle is very large and situated in the axis of the pyramid, the subumbrella is excentric, the stem is abbreviated and not protrusible, while the Eudoxiæ have no special nectocalyx, and become free as in *Cuboides*.

The family Amphicaryonidæ is formed for *Amphicaryon* g. n.; in it the nectocalyces have a rounded exumbrella, and the stem is metamorphosed into a disc; the bud-groups are set free as diplophysiform Eudoxiæ. The Stephanophyidæ contain the new genus *Stephanophyes*, and are defined as Calycophoridæ with four nectocalyces placed like a wreath in the same plane, and with heteromorphous tentacles. In the internodes of *S. superba* sp. n., the heteromorphous tentacles which have been as yet found only in *Stephanophyes* among the Calycophoridæ, are found placed. This species is, of all the Siphonophora known to the author, the most delicate, and one of the most magnificent. It is perfectly transparent, and may be as much as 18 inches long. "The graceful play of its heteromorphous tentacles, the energetic pumping movements of the large calyces and the numerous special nectocalyces, the bright red colouring of the knobbed fluid vessels with their shining oil-drops, the delicate rosy or emerald-green shimmer of the gastric polyps, the perfect transparency of the large globular ova, and the delicate flesh-tint of the male manubria all combine to mark *Stephanophyes* as one of the most splendid objects among pelagic animals." This interesting form passes through a remarkable metamorphosis. The youngest specimens, which are perfectly transparent, and therefore easily escape even the practised eye, display the characters of the genus *Lilyopsis;* they possess two nectocalyces with the fluid-canal only once divided dichotomously, and are completely devoid of the heteromorphous tentacles found in the internodes of older groups. This new genus unites the Prayidæ and

Polyphyidæ, and has some points of structural resemblance to the Physophoridæ.

Passing from the Calycophoridæ to the Physophoridæ, the author points out the many resemblances which connect the two orders. In the embryos of both a heteromorphous rudimentary nectocalyx is formed, which is lost in most if not all Calycophoridæ, while in the Physophoridæ it becomes converted into the pneumatophore. In the more highly organized Calycophoridæ there are a number of calyces of the same form, the close concentration of the buds into Eudoxia-groups is given up, and in some species the stem is transformed, as in many Physophoridæ, into a gemmiparous disc. Here, then, we have a series of characters which seem to indicate that the Physophoridæ took their origin, if not from the Stephanophyidæ or Polyphyidæ, at least from a root common to the two orders. *Stephanophyes* with its heteromorphous tentacles shadows forth a condition which has hitherto been regarded as an exclusive characteristic of the Physophoridæ.

The morphology of *Halistemma pictum* has been closely examined, and it is shown that the order of gemmation is regular; the author leaves it to Prof. Haeckel to reconcile this fact with his theory of the multiplication and dislocation of the medusa-organ on the Siphonophoran stock. In the post-embryonic development of *Crystallodes rigidum* a point of great interest is the peculiar formation of the larval tentacles. Haeckel thinks that the cnidaria of the primary tentacle are directly developed into the definitive cnidaria. Observation, however, has shown that they are larval structures, which, later on, are succeeded by heteromorphous organs. The nectostyles of some gigantic examples of *Forskalia ophiura* were a foot in length.

New Athorybia.*—Mr. J. Walter Fewkes describes *Athorybia californica* sp. n., which differs from any known species in the form of its tentacular knobs. The sacculus, which ordinarily forms a bell-shaped covering, is much modified and reduced in size; it is a globular or hemispherical enlargement which shows the spongy cellular walls which have been described in the knobs of the genus *Rhizophysa*. If the question were raised as to whether this new form was not the young of some long-stemmed Physophore, like *Agalma*, the author confesses that it may be so. But if larval, this new form is different from any larva yet described. The sexual bodies are but little developed, and, even if they were well so, that fact alone would not prove the maturity of the animal, for among the Physophores there are known genera in which the sexual products are matured before the adult form is reached.

Eyes of Acalephæ.†—Herr W. Schewiakoff has examined the eyes of several Acalephæ. He finds that there is great diversity of structure, and that they are so far genetically connected that the simpler only represent developmental stages of such as are more highly organized. In the simplest cases the eyes have the form of a pigment-spot, as in *Aurelia aurita*. These spots are formed of cells, the pigment- and the optic-cells, with two different functions, which are performed in definite areas of the ectoderm, the so-called sensory epithelium. These are the districts from which the light-perceiving spots are developed.

The next step in the further complication of the optic organ consists

* Ann. and Mag. Nat. Hist., iii. (1889) pp. 207–10 (1 pl.).
† Morphol. Jahrb., xv. (1889) pp. 21–60 (3 pls.)

in the sensory epithelium, which is differentiated for the perception of light, sinking into the body and so giving rise to the so-called optic pits; such organs may be found in *Charybdea marsupialis*, and in their composition they differ not at all from the superficial pigment-eyes. Their depression is not only a sign of the more definite localization of the percipient spots, but a protective arrangement. Still deeper depression leads to the so-called goblet-eyes, which are first met with in the proximal goblet-eyes of *Charybdea;* in conjunction with this depression there is the development of a new constituent of the eye—the so-called vitreous body which is differentiated off from the pigment-cells; it closes the eye cup externally and fills its cavity. A further, though less considerable, complication is found in the distal goblet-eyes of *Charybdea*, where the invagination of the sensory epithelium forms a secondary outgrowth. In connection with this we meet with a differentiation of the cellular elements which form the wall of the eye; the cells abutting on the proximal wall of the optic cup are formed of pigment-cells, and this arrangement is functionally that of an iris, for by it the lateral rays of light are cut off.

The goblet-eyes of *Aurelia* are developed on quite a different type. They are not formed, like the other eyes of jelly-fishes, by the invagination of the sensory epithelium, but of the endoderm and, possibly, of the supporting lamella; the goblet-wall is, consequently, formed of altered endodermal cells which are filled with pigment. This invagination of the endoderm is followed by that of the optic cells of the ectoderm. As a result of this interesting mode of origin it follows that the nerve-fibres do not arise from inside but from outside the optic cells, and are connected with their outer ends; the free ends appear, therefore, to be turned away from the light, which must pass through the whole of the nerve-layers before it reaches the ends of the optic cells. This relation of parts is not unlike that which obtains in the eyes of *Onchidia*, Lamellibranchs, Arachnids, and Vertebrates.

The causes, however, are quite different, and the goblet-eyes of *Aurelia* must therefore be regarded as belonging to a special type which cannot be directly compared with any yet known type of eye; there is, indeed, a certain resemblance to the eyes of the Turbellaria.

The structure of the lens-eyes of *Charybdea*, which attain a very high grade of development, is very interesting. They are derived from goblet-eyes, the goblet narrowing at its outer end and becoming constricted off from the body-epithelium. The orifice becomes closed, and an optic vesicle completely shut off from the exterior becomes developed; this is surrounded by the afferent nervous layer as far as its superficial part. In addition to this the body-epithelium grows together at the point where the invagination has taken place, and forms a thin transparent layer—the so-called cornea. Simultaneously with this there is a differentiation of the cells which form the outwardly directed wall of the primitive optic vesicle. These increase greatly in length, and, later on, form the spherical lens which projects into the optic vesicle, and occupies a large part of it. The cells of the vesicle at the periphery of the lens become differentiated into the so-called iris. The proximal lens-eye no doubt arises in the same way as the distal, but the proximally directed and not the outer wall of the vesicle becomes differentiated into the lens; a gelatinous stalk is formed which carries the lens.

This mode of origin and the peculiarities of these eyes of *Charybdea*, cannot be compared with any known type of eye. In some, the structureless lens is developed within the optic vesicle, and is a secretion-product of the cells which compose it; such eyes are to be found in Gastropods, Cephalopods, Annelids, and in *Peripatus*. In others the lens is developed outside the primary optic vesicle, and is either structureless as in many Arthropods, or composed of cells, as in the dorsal eyes of *Onchidium*, and the eyes of Lamellibranchs, and Vertebrates. The vestigial parietal eye of some Reptiles appears to have the same type of lens as the eyes of *Charybdea*, for it is formed from the outer wall of the optic vesicle. There appear, then, to be three types of lens-eyes.

Porifera.

Cliona.*—Dr. J. Leidy gives a short and interesting account of this boring sponge, and describes a new form from the coast of Florida, which he proposes to call *C. phallica;* it has an opening at its summit which is closed when the sponge is disturbed.

Protozoa.

Functional Differentiations in Unicellular Beings.†—M. Fabre-Domergue replies to some criticisms of M. Maupas as to the existence of functional differentiations in unicellular organisms. Taking *Didinium nasutum*, he urges that at the moment when prey is ingested, there is a clear axial tract, resulting from the formation of a canal which extends from the mouth to the anus; the existence of this canal is confirmed by the retraction of its wall under the influence of iodine, and by the course taken by the food which always goes straight from mouth to anus. M. Maupas denies the existence of this canal because it has no proper walls, but he likewise, it is true, denies that an air-bubble has walls. Functional differentiation is still better marked in the excretory system; the most striking example is the remarkable contractile plexus of *Cyrtostomum*, but it is only the most perfect expression of a structure which exists in all Ciliata, and traces of which may be found in a large number of forms.

Maupas' Researches on Ciliata.‡—Prof. A. Gruber does not accept all the general conclusions which Maupas has drawn from his researches on ciliated Infusorians. (1) The multiplication has been shown to occur in asexual cycles, which end in degeneration and death if conjugation does not take place. Therefore, Maupas maintains, the doctrine of the immortality of the Protozoa must be abandoned. But the conjugation always occurs in the natural conditions of life, so that Maupas' objection is not after all serious. It is only necessary to add to Weismann's original statement a saving clause as to the necessity of conjugation. (2) Maupas opposes Weismann in regard to the equality of the products of division. After 50–100 divisions the products are both morphologically and physiologically different. But the species still persists, and Weismann does not deny such variability, nor even the inheritance of acquired characters in the Protozoa. (3) Maupas insists that Weismann should have experimented before he theorized, but

* Proc. Acad. Nat. Sci. Philad., 1889, pp. 70–5.
† Ann. de Microgr., ii. (1889) pp. 168–72.
‡ Biol. Centralbl., ix. (1889) pp. 14–23.

Gruber points out that even Maupas' researches owe their impulse to the precedence of hypotheses.

Gruber notes two cases, one observed by Jickeli, the other by himself, where the micronucleus of a *Paramæcium* appeared to be absent, but where the symptoms of senile degeneration were not exhibited. According to Gruber the macronucleus consists of "histogenetic" plasma, the micronucleus of germ-plasma.

Finally, Gruber refers to his recent experiments on *Actinophrys sol*. The marine form, with few vacuoles, soon acquires them in fresh water, which soaks in much more abundantly. The reverse experiment was also made. The marine *Amœba crystalligera* also became richly vacuolated in fresh water. None of the environmental variations, however, were more than transitory, that is to say, they disappeared when the original conditions were restored.

Two New Infusorians.* — M. Fabre-Domergue describes a new species of *Colpoda*, which he calls *C. Henneguyi*, which was found in an old maceration of leaves and dried detritus collected in the garden of the Collège de France. Its slow movements and its large size would make it comparatively easy to study, were its protoplasm not obscured by fine and numerous granulations. It differs in form from *C. cucullus*, and normal individuals vary from 0·31 to 0·65 mm. in length. After describing the details of its appearance, the author states that it gives rise to division-cysts and to lasting cysts; the former have a very delicate membrane, and the contents divide into four. The lasting cysts are smaller and more rounded, and have a thick and resisting envelope.

Pronoctiluca pelagica is the name given to a new genus of flagellate Infusoria found on the surface of the sea at Concarneau. In the form of its mouth, and the presence of two flagella, it approaches *Chilomonas*, but, on the other hand, its tentacle is exactly like that of a *Noctiluca* minus the striation. The author believes that we have here a form which is intermediate between the Flagellata and the Cystoflagellata.

Anoplophrya aeolosomatis.†—Mr. H. H. Anderson gives a description of a new ciliate infusorian parasitic in the alimentary canal of *Aeolosoma chlorostictum* (Wood-Mason, MSS.). It differs from all members of its genus except *A. mytili* in possessing a single contractile vesicle, and from it it may be distinguished by the shape and form of its endoplast, which is axial, band-shaped, extending nearly the whole length of the body, in most specimens straight, though in a few somewhat curved or S-shaped; this endoplast is coarsely granulated, and in one specimen, five large and highly refractive, though not crystalline, particles of different sizes were seen in it. The surface of the infusorian is densely ciliated, and finely striated in a longitudinal direction. The contractile vacuole is situated centrally above the endoplast. An interesting process of multiplication by transverse fission, was observed to resemble that which takes place in *A. nodulata*. It was noticed that the individuals in process of division were far larger than those that were not being divided, and that the segments were very much smaller than the parent one.

* Ann. de Microgr., ii. (1889) pp. 353–7 (1 pl.).
† Journ. Asiat. Soc. Bengal, lvii. (1889) pp. 381–3 (1 pl.).

Formation of Spores of Gregarine of Earthworm.*—Dr. F. Henneguy has applied the section-method to the study of Gregarines. The two chief difficulties met with are the small size of these creatures, and the resistance offered by their investment to the penetration of fixing liquids; these are best met by hardening the organisms in the organs which contain them. Observations have been made on *Clepsidrina blattarum*, *Klossia helicina*, and *Monocystis agilis*; but the last alone has as yet given good results.

If a series of sections of the so-called testicles of the earthworm are made in May and June, almost all stages in the development of the parasite may be observed. The young consist of a small mass of homogeneous protoplasm, which is surrounded by a delicate membrane, and contains a nucleus of some size, which is provided with a nucleolus which stains deeply with carmine. In the adult the protoplasm is filled with refractive bodies; these, when examined under a high power, are seen to be rounded or ellipsoidal in form, and they may or may not be of the same size. The author agrees with Maupas in regarding these bodies as being amylaceous. From the characters which they present with polarized light, it would seem that their axial portion consists of a substance which is more condensed than the rest.

The general results of previous observers on the development of *Monocystis* are confirmed, and some new facts have been discovered as to the part played by the nucleus. When a Gregarine is about to undergo encystation the nucleus has a large nucleolus, and the surrounding protoplasm is devoid of refractive bodies. Vacuoles soon appear in the nucleolus, and this breaks up into several small grains of chromatin which are connected by an achromatic plexus. The nucleus then undergoes indirect division, and what appears to be an accessory nucleus is developed. If the contents of the cyst do not divide, the nuclei continue to multiply by karyokinesis and emigrate to the surface, where each nucleus is soon surrounded by a small quantity of protoplasm. At the moment when the peripheral layer of the cyst becomes organized into cells one does not see around each nucleus the radiating lines which are observed in the parablast of mesoblastic eggs when the nuclei become the centres of cell-formation. It is very probable that the small size of the cells of the cysts of *Monocystis* alone prevent us from seeing those radiate lines which appear to play an important part in the formation of the cellular plate. Each small superficial cell of the cyst soon becomes surrounded by a resistant envelope, and becomes a spore or pseudonavicella.

Some of the nuclei remain at the centre of the cyst and, later on, undergo degeneration; the process of their disappearance recalls that which Flemming has noticed in the cells of the ovarian follicles of the rabbit. When the contents of the cyst divide into a small number of large masses the process of the formation of the spores is identical, and each of these masses behaves like the undivided cyst. The method of sporulation described by Lieberkühn, in which the whole contents of the cyst divide into spores, has not been observed by the author. Microspores are formed in much the same way as macrospores. It is possible that microspores and macrospores are not formed by one and the same species. Both kinds contain a nucleus of some size, which is provided

* Ann. de Microgr., i. (1888) pp. 97–107 (1 pl.).

with a chromatic plexus; this nucleus divides by karyokinesis; each of the daughter-nuclei passes to one of the ends of the spore, where it undergoes two successive divisions, in such a way that the spore contains two groups of four small nuclei. These pass to the middle of the spore, the protoplasm of which becomes divided into eight falciform nucleated bodies, surrounding the "noyau de reliquat" of Schneider. This nucleus does not take up staining reagents, and the term applied to it is inexact, for it does not exhibit any of the characteristic reactions of a nucleus; it is formed of a mass which is more finely granular and more refractive than the rest of the protoplasm of the spore. It is placed at the centre, and round it the falciform bodies are organized; it seems to diminish in size during the development of the spore and to serve for the nutrition of the falciform bodies. The author proposes to speak of it as the central globule.

Cystodiscus immersus — a Myxosporidium found in the gall-bladder of Brazilian Batrachia.*—Dr. A. Lutz has found in the gall-bladder of certain frogs and toads a parasite which would seem to have no pathological significance. Macroscopically it appears as a thin round transparent disc, sometimes surrounded by a whitish periphery.

Thirty to fifty individuals may be found in one gall-bladder, and in size they sometimes attain to a diameter of $1\frac{1}{2}$–2 mm., with a thickness equal to 1/20–1/10 of their diameter. Under the Microscope these discs are seen to be incased in a transparent structureless membrane, which is very resistant to reagents. The organism has no power of spontaneous movement. The contents of the discs are numerous vesicles, which by close apposition become polygonal. They are not nucleated, and if they are set free they speedily vanish, as does their delicate investing sheath.

The most prominent characteristic of the parasites is the spores, which lie outside the vesicles, and usually in pairs. These spores are of various sizes, and when ripe attain a length of 12–14 μ, and width of 9–10 μ, being oval in shape, with blunt ends. They are made up of two flaps or valves and two almost spherical polar corpuscles. They contain an extensile filament, which exceeds the whole length of the spore four or five times. When indrawn it is spirally rolled up and scarcely visible. By means of caustic potash it can be extruded. The rest of the spore is occupied by a transparent plasma-mass, coagulable by reagents.

With regard to the development of the spores, the author first observed them as oval bodies containing two pale small polar corpuscles, the rest of the body being dark. The latter decreases in size and clears up, the investing membrane *pari passu* appearing, and the polar bodies becoming larger. No nucleus was observed.

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 84–8.

BOTANY.

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

α. Anatomy.*

(1) Cell-structure and Protoplasm.

Growth of the Cell-wall.†—Herr E. Strasburger continues his investigations on the growth and structure of the cell-wall, especially in relation to Wiesner's discovery ‡ of the constant presence of albuminous substances in the cell-wall. Many phenomena connected with the growth of the cell-wall hitherto inexplicable he now explains on the theory of the entrance into it of the living protoplasm, the cytoplasm or hyaloplasm of the cell. In the same way cutinized, suberized, and lignified cell-walls owe their characters to the entrance of foreign substances from without.

The development was especially examined of the spores of the Hydropterideæ (Rhizocarpeæ). In *Azolla* the massulæ are first formed when the formation of the membrane of the microspores is completed. Round the microspores are formed clear borders, consisting of a fluid derived from the surrounding protoplasm; these borders unite with one another so that finally a number of hyaline vesicles are contained within the microsporange, separated from and surrounded by the hyaloplasm. From these vesicles the massulæ are formed, which are therefore derived from the hyaloplasm which has entered the vesicles. When mature the massulæ resemble in structure cutinized cell-walls. The same substance from which massulæ and glochids are formed in the microsporanges gives rise in the megasporanges to the peculiar floating apparatus. The perinium on the megaspore of *Salvinia* is a structure of the same origin.

In the formation of the pollen-grains of the Onagrarieæ a similar process takes place; and in those pollen-grains which are provided with spines or other prominences projecting outwards, these are formed out of a living substance which enters the extine from the hyaloplasm. Similar observations were made on the development of the elaters of *Equisetum*, on the spore-membranes of *Riccia* and *Sphærocarpus*, on the oogones of *Peronospora*, &c.

In epidermal cells it was proved in a number of instances that the cuticle-layer originates as a lamella of cellulose, and that it is only later that the substance which brings about the cuticularizing enters the cell-wall; this substance is not cutin, but is a living constituent of the body of the cell. In the processes of suberization and lignification the nature of the changes is not so clear; but all striation and stratification are probably the result of the introduction into the constitution of the cell-wall of a foreign substance derived from the hyaloplasm.

Structure of the Cell-wall.§—According to M. L. Mangin, the first division-wall formed in cell-division consists of pectose, on both sides of which layers of cellulose are then formed, while it increases itself in

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

† 'Ueb. d. Wachsthum vegetab. Zellhäute,' 8vo, Jena, 1889, 186 pp. and 4 pls. See Bot. Centralbl., xxxvii. (1889) p. 394.

‡ Cf. this Journal, 1886, p. 818. § Comptes Rendus, cvii. (1888) pp. 144–6.

thickness and becomes the middle lamella of the wall. In many cases pectose is also a constituent of the thickening-layers, so that the form of the cell-wall is retained after destruction of the cellulose; less often the thickenings consist of pure cellulose. The walls of the tapetal cells in young anthers and those of young pollen-cells are composed, according to the author, entirely of pectose. Conversion into mucilage and cuticle are results of the transformation of pectose, not of cellulose.

Permeability of Protoplasm for Urea.*—Herr H. de Vries states that the protoplasm of mature cells can take up urea. Comparing the rapidity of diffusion of urea with that of glycerin, he finds an illustration of the general law that the diffusibility of a substance is in inverse proportion to its molecular weight; that of glycerin $C_3H_8O_3$ (= 92) being considerably less than that of urea CON_2H_4 (= 60). The isotonic coefficient of urea he places at 1·70.

Diosmose through the Cellulose-pellicle of Phragmites communis.†—According to Herren Kruticky and Bielkowsky, the cellulose-pellicle of this grass has a greater endosmotic equivalent than that of any artificial membranes hitherto used for the purpose. In the manometer the endosmotic force withstands a pressure of nearly one atmosphere. The limit of elasticity amounts, on the average, to above 500 gr.

Reduction of Silver in the living-cell.‡—Prof. W. Pfeffer strongly contests the assertion of Loew and Bokorny,§ that the reduction of silver from a slightly alkaline solution is a conclusive proof of the presence of "active albumin," and consequently of the cell being in a living condition, which he asserts to rest on pure hypothesis. With the death of the cell and its immediate result—the mixing of substances previously separated, and the exosmotic separation of substances previously in contact—changes of various kinds are effected, of the chemical nature of which we at present know very little.

Messrs. Loew and Bokorny reply ‖ to Dr. Pfeffer's objections, referring, in proof of the correctness of their conclusions, to the records already published of their researches. In particular they assert that the reduction of the silver-salt cannot be due to the presence of tannin, at all events when this substance is not present in any large quantity.

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

Chemistry of Chlorophyll.¶—Dr. E. Schunck gives a short *resumé* of the present state of our knowledge on the chemistry of chlorophyll, and also adds a few new facts to the stock already accumulated.

In works on vegetable physiology the term chlorophyll is sometimes applied to the complex of substances contained in living green cells, which take part in the process of assimilation, and of which the colouring matter constitutes a portion; and chemists, following the example of physiologists in giving a name to the whole which should have been confined to one part, have been led to ascribe to chlorophyll properties which no mere chemical substance can possibly possess. The author

* Bot. Ztg., xlvii. (1889) pp. 309–15, 325–34. Cf. this Journal, 1888, p. 617.
† Arbeit. St. Petersburg. Naturf. Gesell., xix. (1888) p. 3. See Bot. Centralbl., xxxviii. (1889) p. 486.
‡ Flora, lxxii. (1889) pp. 46–54.
§ Cf. this Journal, 1881, p. 906.
‖ Bot. Centralbl., xxxviii. (1889) pp. 581–4, 612–5.
¶ Ann. of Bot., iii. (1889) pp. 65–121 (1 pl.). Cf. this Journal, 1887, p. 606.

then, to avoid misconception when using the term chlorophyll, means simply the substance, or it may be mixture of substances, to which the pure green colour of ordinarily healthy leaves and other vegetable organs is due. The various attempts to isolate chlorophyll are then described. Berzelius, Mulder, Morot, and Frémy all employed processes for preparing chlorophyll involving the use of hydrochloric acid, and really obtained products resulting from its decomposition. M. Gautier prepared chlorophyll with neutral solvents, and obtained a substance in distinct crystals of an intense green colour; this product, as well as Hoppe-Seyler's chlorophyllan, are probably derivatives of chlorophyll. The product obtained by Hansen, chlorophyll-green, is however a sodium compound, and the author's conclusion is that chlorophyll has not yet been obtained in such a state of purity as to allow of its physical and chemical properties being described. Most observers agree in stating that chlorophyll is insoluble in water and soluble in ether, chloroform, carbon disulphide, ethereal and fatty oils, and similar substances. That iron in some form or other is an essential constituent of chlorophyll, has been repeatedly asserted and as often denied; the author is of the opinion that it is not.

The absorption-spectrum of chlorophyll presents several points of controversy, especially the broad indistinct bands at the blue end of the ordinary chlorophyll-spectrum, which are only seen by sunlight, and are distinguished as bands V. and VI. (German notation). Some observers consider these as true chlorophyll-bands, while others are of opinion that they belong to a yellow colouring matter accompanying chlorophyll called xanthophyll. The author takes this latter view, seeing that it is possible to isolate a colouring matter from leaves in regular lustrous crystals, which gives yellow solutions showing two distinct bands in the blue when sufficiently dilute, but no bands whatever in the red, yellow, or green, however concentrated they may be.

Dr. Schunck then describes the products formed in the processes of decomposition to which chlorophyll has been hitherto submitted. By the combined action of ether and hydrochloric acid, Frémy obtained two colouring matters, a blue and a yellow; these he named phyllocyanin and phylloxanthin. Phyllocyanin is one of the most important derivatives of chlorophyll, its properties being very interesting. When dry it has the appearance of a dark-blue mass, which, when examined under the Microscope, is found to consist almost entirely of elongated rhomboidal or irregularly six-sided crystalline plates, which are generally opaque, but, when very thin, are translucent, and then appear olive-coloured by transmitted light. Phylloxanthin is the product obtained by dissolving the precipitate formed by acids in an alcoholic extract of leaves in ether, and adding concentrated hydrochloric acid to remove the phyllocyanin, where it remains dissolved in the upper ethereal liquid. Solutions of phylloxanthin have a yellowish-green colour, with a pronounced reddish tinge, and may be thereby distinguished from solutions of phyllocyanin, which are more decidedly green. They show a spectrum of four bands only, that of phyllocyanin having five; an admixture of the latter with phylloxanthin may therefore be easily detected.

Dr. Schunck then describes the various compounds of phyllocyanin, and also the action of alkalies on chlorophyll, which has been less frequently studied than that of acids, partly perhaps because alkalies do not produce such marked changes as acids. One of the most interesting substances obtained by the action of alkalies is phyllotaonin, thus called by the author from its resemblance in colour and lustre to the eyes in a peacock's tail. The action of anilin on chlorophyll is then described, and the properties of a substance termed anilophyll are enumerated.

The author concludes by discussing the chemical constitution and functions of chlorophyll. It may be assumed that chlorophyll is a kind of lecithin, of which phyllocyanin forms as it were the nucleus, together with an unknown acid and an unknown base; and he brings forward the hypothesis that the unknown acid may be carbonic acid. The presence of a body having a chemical constitution such as that would, it is evident, serve a useful purpose in the vegetable economy. Some remarks are also made on the substances which accompany chlorophyll, and on the chlorophyll of animals.

Formation of Chlorophyll by Coniferæ in the dark.* — Herr H. Molisch states that *Gingko biloba* (*Salisburia adiantifolia*) furnishes an exception to the general rule that seedlings of conifers have the power of forming chlorophyll even when completely excluded from light. Not a trace could be detected in a considerable number of observations.

Formation of Starch in the Leaves of Sedum spectabile.†—Prof. J. Böhm adduces further evidence of his view of the incorrectness of the assumption that, because starch is again rapidly formed in leaves from which it has been removed by subjecting them to darkness, when again exposed to the light in air containing carbon dioxide, that therefore the starch then found in the chlorophyll-grains is a direct product of assimilation. His experiments were made on the coriaceous leaves of *Sedum spectabile*, and confirm his previous conclusion that when the starch has been removed a large quantity of sugar still remains in the leaves, which, on fresh exposure to light, is converted into starch.

Mode of occurrence of Tannin in Plants.‡—According to Herr H. Moeller, tannin occurs in plants in two different forms:—(1) As an iron-green solution in the cell-sap, commonly permeating the cell-wall, as also the nucleus and chlorophyll-grains. With potassium bichromate this tannin is precipitated in the form of an irregular amorphous powder. (2) Much the most common form is that of a homogeneous strongly refringent oily fluid, usually coloured blue by iron-salts. This form can be especially well detected in leaves of *Pelargonium* by Gardiner's reagent (ammonium molybdate). An examination was made of leaves of a number of different plants, and the author concludes from the concurrent presence of tannin and starch in the assimilating cells, and the separate occurrence of each in the conducting tissue, and especially from the large accumulation of tannin in spongy parenchyme, parenchyme-sheaths, and the conducting parenchyme of vascular bundles, that the transference of the carbohydrates in the form of compounds of tannin is highly probable.

(3) Structure of Tissues.

Assimilating Tissue and Periderm in leafless plants.§—Sig. H. Ross has examined the structure and development of the assimilating

* Oesterr. Bot. Zeitschr., xxxix. (1889) pp. 98-9.
† Bot. Centralbl., xxxvii. (1889) pp. 193-201, 225-32.
‡ Ber. Deutsch. Bot. Gesell., vi. (1888) General-Vers.-Heft, pp. lxvi.-lxxxii.
§ Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 215-45 (1 pl.).

tissue or chlorenchyme, and of the periderm, in the branches of plants with few or no leaves. Such plants generally manifest a tendency to preserve for a long time unchanged the cortex and the epiderm, in order to render possible a sufficient assimilation; the increase in thickness is at first inconsiderable; and hence the formation of periderm is retarded. In some cases the periderm covers only a part of the branch; in others it grows in the form of spots or longitudinal lines scattered irregularly over the surface, which, after a certain time, unite to form a continuous periderm round the whole of the branch. When increase in thickness commences, the necessary space for the new tissues is obtained by the rounding of the branches which were at first flattened, or by the enlargement of sinuosities, so that the assimilating tissue may be preserved for the longest possible time. In other cases the periderm is developed among the groups of assimilating tissue in the form of regular longitudinal strips, which broaden in proportion to the increase in thickness of the branch. This assimilating tissue may or may not undergo subsequent changes. In *Genista*, where the groups of stereids extend almost without interruption from the epiderm to the leptome, through the whole breadth of the outer cortex, the periderm is formed in the middle of the strips of assimilating tissue, that is to say, at the bottom of the original sinuosities, preserving for a long time at its two sides remains of the chlorenchyme.

Closing of the Bordered Pits in Coniferæ.*—Herr K. Pappenheim proposes for solution the question whether the bordered pits in the alburnum of the wood of Coniferæ are capable of being closed, and if so, by what forces this is brought about. Taking the silver fir as an example, he describes a mechanical apparatus by means of which he claims to have proved that this can take place in the alburnum of the spring and summer; and he believes this fact to be of importance in constructing a theoretical explanation of the course of the ascent of sap.

Structure of Lecythidaceæ.†—M. M. O. Lignier finds in the course and arrangement of the vascular bundles a constant difference between the Lecythidaceæ (Lecythideæ, Barringtonieæ, and Napoleoneæ), and the typical Myrtaceæ. In the former the anterior and posterior bundles of the leaf-stalk are branches from the margins of the main cauline bundles; the cortical bundles of the stem are normal leaf-trace-bundles.

(4) Structure of Organs.

Anatomy and Chemistry of Petals.‡—Dr. E. Dennert describes the structure and the colour of petals in a large number of plants. The following are the more general results arrived at.

As compared with foliage-leaves, petals show usually much less development of tissue, and the veins are of simpler structure and less branched. The number of stomates is usually comparatively small; in some instances, as the perianth-leaves of *Ornithogalum umbellatum*, they occur on both sides; in this plant long crystal-cells filled with raphides occur between the epidermal cells. The cells of the epiderm of petals do not generally exhibit any differentiation in the development of their

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 2–19 (1 pl.).

† Ass. Franç. pour l'Avancem. des sci., 1887, 9 pp. See Bot. Centralbl., xxxvii. (1889) p. 145.

‡ Bot. Centralbl., xxxviii. (1889) pp. 425–31, 465–71 513–8, 545–53.

cell-walls. Their usual form is that of papillæ. As a rule yellow petals have a stouter structure than those of other colours.

The colouring-matters of petals may be divided into two classes—granular, and dissolved in the cell-sap; the former include, as a rule, green, yellow, and orange, the latter red, blue, and violet petals. These two kinds are sharply differentiated from one another, but are not unfrequently mixed, as in the orange pigment of *Colutea cruenta* and *Fritillaria imperialis*, and the brown of the wallflower. A yellow pigment dissolved in the cell-sap is, however, not uncommon. The granular substances, which may be called anthoxanthin, are a modification of chlorophyll; the soluble pigments, known under the general name of anthocyan, a modification of tannin. These relationships are proved by a number of experiments described in detail. The variation in the colour of petals of the same or of allied species depends on the extent of the metamorphosis of the tannin into the pigment, and on the presence or absence of the yellow colouring-matter. The nature of the chemical change in the transformation of the tannin is probably an oxidation, and it is largely dependent on light.

As regards the distribution of the pigments; the general rule, though not without many exceptions, is that anthocyan occurs in the epiderm and veins, the yellow pigment in the lower-lying tissue. Anthocyan has clearly a close relationship to the erythrophyll of leaves.

Extrafloral Nectaries.*—Herr E. Ráthay asserts the existence of extrafloral nectaries in a large number of species of *Centaurea* and in other genera belonging to the Compositæ. The purpose of these organs is not the same in all plants. They may exist for the purpose of digestion, as in *Nepenthes*, or for the attraction of insects, such as ants, which would otherwise injure the flowers, as in *Impatiens tricornis*. They were found to contain a larger or smaller quantity of sugar in all cases except the common peony. Although the insects most commonly found in extra-floral nectaries are ants, yet in sunshine they appear almost always to attract many others, Coleoptera, Hymenoptera, and Diptera; and the term myrmecophilous plants sometimes applied to them is therefore inexact. The sugar-producing parasitic Uredineæ, to which the author has already called attention,† appear to benefit the host-plant in the same way as extra-floral nectaries.

Extrafloral Nectaries of Dioscorea.‡—Herr E. C. Correns describes these organs in about twelve species of *Dioscorea*, those of *D. sativa* and *Batatas* having been especially studied. They are wanting in *Testudinaria elephantipes*. These depressed glands occur on the under side of the leaf and in the cortical parenchyme of the stem and leaf-stalk. They consist of a mass of cells rich in protoplasm and containing a large nucleus, on the level of the hypodermal layer, their form being ellipsoidal in the leaf, fusiform in the stem and leaf-stalk. The secreting surface, which has no epiderm in a physiological sense, is elliptical or lanceolate, and is covered by a continuous cuticle. The peripheral layer of cells is suberized in the mature nectary, and therefore represents a protecting sheath. The leptome of the vascular bundles is connected by transitional cells with the parenchyme-sheath which surrounds the

* SB. Zool.-Bot. Gesell. Wien, xxxix. (1889) pp. 14–21. Cf. this Journal, *ante*, p. 87.

† Cf. this Journal, 1883, p. 246.

‡ SB. Akad. Wiss. Wien, xcvii. (1889) pp. 651–74 (1 pl.).

nectaries of both stem and leaf. The nectary is formed at an early period from a single epidermal cell, and the sheath from one or from a very few cells lying directly beneath the mother-cell of the nectary.

Elastic Stamens of Compositæ.*—Prof. T. Meehan describes the mode in which, in a large number of species of Compositæ, the column of stamens matures its growth before the pistil becomes fully elongated; the pistil, unable to push through the column, bears it upon its apex until the downward pressure is so great that the pistil bursts through, when the elastic filaments at once draw the anthers down to their proper position on a level with the limb of the corolla. The phenomenon is attributed by the author to elasticity rather than to irritability.

Glands on the Stamens of Caryophyllaceæ.†—Prof. T. Meehan calls attention to the existence of glands at the base of the stamens in the chickweed and other species of *Stellaria*, and in *Cerastium* and *Arenaria*. At times these glands exude an enormous quantity of a viscid, slightly sweet fluid, which does not appear to have for its primary function the attraction of insects, since the chickweed is self-fertilized, though bees do occasionally visit these flowers for the sake either of the nectar or of the pollen.

Fruit of Nyctagineæ.‡—According to Herr A. Heimerl the conversion into mucilage of the outer layers of the fruit in this order is, with a few exceptions, characteristic only of the Mirabilieæ. The absorption of water takes place always in a layer lying immediately beneath the epiderm, which covers the surface of the fruit, consisting of palisade-cells, the epiderm then peeling off. The drops of mucilage exuded in this way sometimes contain starch-grains. The form of the epidermal cells varies in the different groups. The author found calcium oxalate to be a widely distributed constituent in the outer and often also in the lateral walls of the epiderm of the fruit in the Mirabilieæ; the form and arrangement of the particles of this salt vary greatly.

Anatomy of Leaves.§—After restating the observations of Areschoug, Jönsson, Haberlandt, and others, on this subject, Herr O. Loebel gives an account of his own observations, chiefly relating to details of structure in the case of particular genera and species.

The increase of surface of the palisade-cells, brought about by foldings of their cell-walls, the author finds to occur alike in Dicotyledons, Monocotyledons, and Ferns. The walls of the palisade-cells are composed of pure cellulose, and are usually thin; when thicker, they are abundantly provided with pores. In both Monocotyledons and Dicotyledons their position is occasionally oblique to the surface. The spongy parenchyme usually contains but little chlorophyll; occasionally starch is found in it. The parenchymatous sheath surrounding the vascular bundles usually consists of a single row of cells from one and a half to two times as long as broad; in some land and water plants it is altogether wanting. In cylindrical leaves the xylem-portion of the vascular bundles is surrounded by the phloem-portion.

* Bull. Torrey Bot. Club, xvi. (1889) pp. 68–9.
† Proc. Acad. Nat. Sci. Philad., 1888, pp. 396–8.
‡ SB. Akad. Wiss. Wien, xcvii. (1889) pp. 692–703 (1 pl.). Cf. this Journal 1888, p. 82.
§ Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 38–77 (2 pls.).

Fixed daylight position of Leaves.*—Herr G. Krabbe agrees with A. B. Frank in attributing the fixed position assumed by the lamina of leaves in diffused daylight to the influence of light without the assistance of geotropism or of internal forces. The experiments were made on *Dahlia*, *Fuchsia*, *Phaseolus*, *Pelargonium*, and other plants. The position depends on the heliotropic properties of the leaves themselves, and is unaffected by their weight, even when this is artificially increased. The movements of the leaf-stalk which bring about the diurnal position of the lamina take place only in its upper region; and these movements, which finally bring the surface of the lamina perpendicular to the incident rays of light, are the result of heliotropism only. This movement of the leaf-stalk is of the nature of a curvature, not of a torsion. Torsion of the leaf-stalk is always the result of the co-operation of two distinct forces, such as heliotropism and geotropism, in different planes.

Structure and Function of the Bladders of Utricularia.†—Herr M. Büsgen has examined the structure of the bladders of *Utricularia vulgaris*, for the purpose of determining whether they can have any other function than that of serving for the nutrition of the plant. The suggested purposes of protecting the plant from being devoured, and of serving simply as swimming-organs, he finds to be inadmissible. The number of fresh-water crustacea, chiefly Cypridineæ, captured is very large, and the "antennæ" and long hairs with which the bladders are furnished are admirably contrived to assist these animals in finding their way into the bladders. Around the entrance to the bladder are a number of glandular hairs, from which is exuded a mucilage very difficult to detect in the water; and this mucilage seems to be the attraction to the animals. The cause of death of the animals is not clear; nor was the actual digestion of their bodies demonstrated; but a series of experiments carried out by Herr Büsgen on plants in which animals gained access to the bladders and on others where this was impossible, showed almost invariably a greater vigour of growth for the former.

Stomates of Gramineæ and Cyperaceæ.‡—Herr S. Schwendener finds that the mechanism of the stomates of the Gramineæ and Cyperaceæ differs to a certain extent from that of other Angiosperms. The broadened end of the guard-cells appears to play an important part in the process, enlarging the size of the opening by an increase of their turgidity. Only in a few cases could any participation of the adjacent cells in this process be detected. In those species which inhabit the steppes, the desert, and other arid situations, special contrivances occur to protect the stomates from excessive transpiration; and these are found also in some species of *Carex* which inhabit marshes; these, the author conjectures, must be immigrants from a more northern latitude.

With regard to the systematic value of the structure of the stomates, he finds that, while their special form in Gramineæ and Cyperaceæ is peculiar to those orders, and marks them off sharply from the Juncaceæ and other allied orders, there are other anatomical characters common to the Cyperaceæ and Juncaceæ, and others again to the Gramineæ, Cyperaceæ, and a portion of the Juncaceæ.

* Jahrb. Wiss. Bot. (Pringsheim), xx. (1889) pp. 211–60 (1 fig.).

† Ber. Deutsch. Bot. Gesell., vi. (1888) General-Vers.-Heft, pp. lv.–lxiii.

‡ SB. K. Preuss. Acad. Wiss., 1889, pp. 65–79 (1 pl.). Cf. this Journal, 1882, p. 216.

Stomates of Coniferæ.*—Herr O. Strübing describes the structure and position of the stomates in 30 genera and 132 species of Coniferæ. *Juniperus* is the only genus in which the species can be grouped according to the position of these organs.

Water-pores in Cotyledons.†—Mr. R. Turnbull describes the distribution of the water-pores on the cotyledons of a number of plants. They are usually found on the upper surface of the cotyledon, and when they are present, the upper surface is nearly or entirely destitute of stomates. In several species of *Campanula* they are crowded on a triangular patch near the apex of the cotyledon distinguished by its smaller epidermal cells; they resemble the stomates in structure, but are smaller. In the cotyledons of *Collinsia grandiflora* the water-pores open into large chambers. In those of *Urtica pilulifera* there is an apical patch of very crowded water-pores on the upper surface. In *Polemonium cæruleum* there are a few on the under, none on the upper surface. In the cotyledons of *Convolvulus major* (*Pharbites purpurea*) are large cavities surrounded by palisade-parenchyme.

Tigellum of Trees.‡—M. L. Flot describes the structure of the tigellar region of the stem of trees, which he defines thus :—In the plant of one year old the cauline portion may be considered as the equivalent of a branch of the mature tree, developing by the prolongation of a specialized region intermediate between the stem properly so called and the root. This region often includes, besides the morphological tigellum (hypocotyledonary axis), a larger or smaller portion of the epicotyledonary axis, and appears to proceed from the development of organs already formed in the embryo. This is the tigellar region.

Bacillar Tumours of the Olive and of Pinus halepensis.§—M. E. Prillieux states that the olive may often be noticed with bacillar tumours similar to those which have been recently described by M. Vuillemin as growing on *Pinus halepensis*.‖ The author gives the details of a comparative study which he has made of these tumours, especially from an anatomical point of view. The tubercles of *Pinus halepensis* present many points of analogy with those of the olive, and their mode of development seems to be the same. The author, however, does not agree with M. Vuillemin when he states his belief that the bacilli penetrate at first to the cambium, and that this meristematic layer becomes the point of departure of ramifying canals, in the interior of which the colonies of bacilli are inclosed. The author has examined many young tumours, and has always found the lacunæ to exist in the middle of the parenchyme. The proliferation of the cells round the lacunæ is much more active in the pine than in the olive.

Tubercles on the Roots of Galega officinalis.¶—Prof. F. Delpino has examined the tubercles on the roots of this species of Leguminosæ, for the purpose of determining their nature and origin. On first examining them he found the parenchymatous cells filled with the ordinary bacteriiform bodies, in which he detected a slight motion of translation. The specimens were now planted in pure water, and again

* 'Die Vertheilung d. Spaltöffnungen b. d. Coniferen,' 8vo, Königsberg, 1888, 76 pp. See Bot. Centralbl., xxxviii. (1889) p. 568.
† Ann. of Bot., iii. (1889) pp. 123–9 (5 figs).
‡ Comptes Rendus, cviii. (1889) pp. 306–8.
§ T. c., pp. 249–52.
‖ Cf. this Journal, *ante*, p. 243.
¶ Malpighia, ii. (1888) pp. 385–94.

examined after some days. They had put out a quantity of new roots, but on none of these were there any tubercles. The bacterioid bodies had now assumed the form of true bacilli, and had become elongated and septated, and had transferred themselves into isolated somewhat swollen cells. The tubercles he considered unquestionably as pathogenous products of the nature of bacteriococcidia, and to have no importance whatever in supplying nutriment to the plant. The plants so affected he found produced no fruit, probably from an insufficiency in the supply of phosphorus and magnesia.

Tubercles of Ruppia and Zannichellia.*—Herr E. Hisinger confirms Goebel's statement that the tubers frequently found on *Ruppia rostellata* and *Zannichellia polycarpa* are caused by a parasitic fungus (Myxomycete) *Tetramyxa parasitica*.

Lateral Roots of Monocotyledons.†—In continuation of his researches on this subject, Sig. A. Borzì now describes the structure of the lateral roots in *Phormium tenax*, *Agapanthus umbellatus*, *Dracæna Hendersoni*, *Cordyline stricta*, *Agave mexicana*, and *Fourcroya gigantea*, all belonging to his fourth type.

β. Physiology.‡

(1) Reproduction and Germination.

Intracellular Pangenesis.§—Prof. H. de Vries proposes a modification of Darwin's provisional hypothesis of pangenesis. He assumes that the nucleus of every cell used in propagation contains all sorts of pangens of the species of animal or plant to which it belongs. As all other nuclei of the full-grown being owe their origin to repeated divisions of the first, they can all be in possession of a complete set of pangens, which can propagate themselves when a division takes place. In the nucleus the greatest part of them remain inactive through life, with the exception only of those pangens which determine the visible characters of the nucleus itself, such as its special mode of division, &c. All other organs of the protoplast essentially contain only pangens corresponding to the characters which they are capable of displaying. It is, however, by no means necessary that they should be all at all times in an active state; thus plastids are in some cases known to exhibit alternately the power of forming starch and some colouring matter. But usually no doubt these organs contain a large number of active pangens. Inactive pangens from the nucleus can migrate to those other organs of the protoplast whose characters they represent; they can again propagate themselves here, and in most cases sooner or later become active, thus bringing to light certain characters. This migration, as shown by the facts of sexual reproduction, must occur soon after fecundation has taken place; but there is no reason why it could not happen in many other phases of development, perhaps even every time a cell divides. This migration of pangens may be effected by the movements of protoplasm.

* Medd. af Soc. Faun. et Flor. Fenn., xiv. pp. 53–7 (10 pls.). Cf. Bot. Centralbl., xxxvii. (1889) p. 316. Cf. this Journal, 1885, p. 292.

† Malpighia, ii. (1888) pp. 394–402. Cf. this Journal, 1888, p. 762.

‡ This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

§ 'Die Intracelluläre Pangenesis,' 8vo, Jena, 1889, 212 pp.

Dichogamy.*—According to Prof. T. Meehan, dichogamy (proterandry and proterogyny) has frequently no connection with any provision for aiding cross-fertilization, but is dependent on the different conditions under which the male and female organs of flowers are produced, the male organs requiring, as a rule, a smaller degree of heat for their maturity than the female.

Fertilization by Snails.†—Herr F. Ludwig finds that *Leucanthemum vulgare* is pollinated in wet weather, in the absence of the ordinary insect-visitors, by a nocturnal snail, *Limax lævis*, attracted by the white ray-florets, on which it feeds.

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

Physiology of Growth.‡—Herr J. Wortmann gives the details of a number of experiments, chiefly on *Butomus umbellatus* and *Phaseolus multiflorus*, which confirm his previous conclusions that growth is due not merely to the force of turgidity in the cell, but partly to a force located in the cell-wall itself. Among the more important general results obtained are the following. The extensibility of the shoot is greatest at its apex, gradually diminishing thence to the base. In the entire growing region below the point of maximum growth up to that point where growth has ceased, there is no variation in the intensity of the turgidity, at all events not sufficient to have any effect on the growth. The turgidity of the point of maximum growth may therefore be regarded as constant. In the region between the terminal bud and the zone of maximum growth there is, in the youngest cells which have not yet begun to elongate, a rapid increase of turgidity, which becomes less marked when the cells begin to elongate, but continues as far as the zone of maximum growth, in which it attains its highest and constant intensity. The production of cell-wall gradually increases from the commencement of growth in length until the period of maximum growth, and then gradually and slowly decreases until it reaches zero in the mature cells.

From experiments on the growth of seeds of *Lepidium*, Herr Wortmann was able to confirm the theory of Sachs and de Vries that the growth of the cell and the increase in superficies of the cell-wall depend directly on the intensity of the turgidity and consequent tension of the cell, the latter having for one of its factors the extensibility of the cell-wall. The superficial growth of the cell-wall takes place mainly by apposition, though this is sometimes assisted by intussusception.

Descending Current of Water.§—Herr J. Wiesner gives the following demonstration of the existence of a descending current in plants. If a cut leafy branch of the vine is immersed in water, all the succulent parts swell up from increased turgidity; but if it is now lifted up so that the leaves are elevated above the water while the apex of the shoot still remains submerged, this latter becomes flaccid, which can be accounted for only by the sap having passed out of it by a descending current into the lower leaves. Although this descending current has not

* Proc. Acad. Nat. Sci. Philad., 1888, pp. 391–4.

† SB. Gesell. Naturf. Freunde Berlin, 1889, pp. 16–8. See Bot. Centralbl., xxxvii. (1889) p. 392.

‡ Bot. Ztg., xlvii. (1889) pp. 229–39, 245–53, 261–72, 277–88, 293–304 (7 figs.). Cf. this Journal, 1888, p. 615.

§ Bot. Ztg., xlvii. (1889) pp. 1–9, 24–9.

nearly the importance of the ascending current, it is not without physiological significance to the plant. The author states that it has a definite influence in the opening of many flowers and inflorescences, in consequence of the passage of water from the flowers themselves into the foliage beneath them, in the formation of sympodial leafy shoots, terminal and axillary buds, &c.

Influence of Light on the Development of Bark.*—M. H. Douliot finds that the development of bark does not depend in any way on the action of gravitation, the under and upper sides of a horizontal branch being quite homogeneous when equally illuminated. But on an erect stem the development of bark is always greater on the south side, which receives a larger amount of light, than on the north side. The author suggests that this may be due to greater transpiration, moisture acting unfavourably on the formation of periderm.

Periodical Activity of the Cambium in the Roots of Trees.†—By observations made on seventeen species of trees belonging to the Dicotyledons and Conifers, Herr L. A. Gulbe has determined that the activity of the cambium begins in the spring in the slender branches, advances from there to the trunk, then into the thicker, and finally into the slender roots, about four or five weeks from the commencement of the activity. In the autumn the decrease of activity takes place in the same period, varying within about two months, and finally ceasing in the second half of October.

Penetration and Escape of Gases in Plants.‡—M. L. Mangin gives the following summary of the laws which regulate the penetration and exhalation of gases in plants.

The diffusion through cutinized surfaces is independent of variations in temperature within the limits of the plant; it is, for each gas, proportional to the difference of the pressures which the gas exercises on the two surfaces of the membrane. The rapidity of diffusion varies with different gases. The coefficient of permeability, i. e. the amount of carbon dioxide diffused per hour and per square cm. of surface, is greater in the case of submerged than of aerial leaves; when the two surfaces of the leaf are unlike, it is usually greater on the lower than on the upper surface. The permeability does not depend on the thickness of the cuticle, but altogether on the extent to which it is impregnated with wax, a certain amount of waxy matter being present on all leaves, whether submerged or aerial. The duration of the life of leaves influences their permeability, deciduous being often more permeable than persistent leaves; other things being equal, the number or size of the stomates increases in proportion as the permeability decreases. The closing of the stomates by a covering which preserves intact the permeability of the membranes diminishes the exchange of respiratory gases from one-fifth to one-half; but the diminution ceases when the temperature is low; it is greatest with young and deciduous leaves. The diminution of respiration on the closing of the stomates is due entirely to the insufficient supply of oxygen. The process of assimilation is also

* Journ. de Bot. (Morot), iii. (1889) pp. 121-4 (8 figs.).

† Arb. St. Petersburg. Naturf. Gesell., xviii. p. 45. See Bot. Centralbl., xxxviii. (1889) p. 487.

‡ Ann. Sci. Agron. Franç. et Étrang., i. (1888). See Journ. de Bot. (Morot), iii. (1889) Rev. Bibl., p. iv. Cf. this Journal, 1888, p. 763.

hindered by the closing of the stomates from the reduction of the supply of carbon dioxide. The coefficient of permeability of membranes is usually, except for respiration at low temperatures, too low for the exchange of gases to take place with its normal intensity; hence the need of stomates for aerial plants.

Assimilation of Free Nitrogen by the Lower Organisms.*—In pursuance of previous investigations on this subject, Herr B. Frank claims to have determined experimentally that very low algal (or protophytal) forms of life, such as *Oscillaria*, *Ulothrix*, *Pleurococcus*, *Chlorococcum*, and the protoneme of mosses, have the power of removing the free nitrogen from the atmosphere and forming therefrom nitrogenous compounds. This property he believes therefore to be common to all vegetable organisms which contain chlorophyll, and that, in all probability, it is, like the assimilation of carbon, a function of their protoplasm. Whether the chlorophyll-pigment takes any part in the process must remain at present undetermined.

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

Respiration of the Fig.†—Dr. C. Lumia has examined the composition of the gas contained within the immature receptacle (fructification) of *Ficus carica*, and finds it to consist of about 5·25 per cent. CO_2, 17·9 per cent. O, and 76·83 per cent. N. The proportion of carbon dioxide is therefore about 130 times that present in the atmosphere, showing that respiration must take place within the cavity of the fig with extraordinary energy.

Process of Oxidation in Living Cells.‡—Herr W. Pfeffer argues against the existence of either ozone or hydrogen peroxide in the living cell, on the ground that even the smallest quantities of the former substance are fatal, while the latter rapidly colours the tissues a red-brown in consequence of a process of oxidation, but without destroying the activity of the protoplasm. There are, however, some tissues which are not coloured in this way. Cells containing a soluble pigment are bleached by the oxidation of the pigment.

Oxalic Fermentation.§—Herr W. Zopf finds in beer-wort-gelatine a Schizomycete to which he gives the name *Saccharomyces Hansenii*, which forms endogenous spores, and which possesses the remarkable property of producing oxalic acid instead of alcohol. This is the result of the fermentation of carbohydrates belonging both to the grape-sugar and to the cane-sugar group.

γ. General.

Young State of Plants.‖—Prof. K. Goebel contrasts the mature and the young forms in a number of illustrations drawn from the higher families of the vegetable kingdom, viz.:—Florideæ (especially *Lemanea* and *Batrachospermum*), Musci (especially *Sphagnum*, in which he finds invariably a flat prothallium, whether the spores germinate in water or not), Hepaticæ, Pteridophyta, and Phanerogamia. As a general rule, when the early differs from the mature form of a plant, it must be

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 34–42. Cf. this Journal, *ante*, p. 412.
† Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 317–20.
‡ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 82–9. § T. c., pp. 94–7.
‖ Flora, lxxii. (1889) pp. 1–45 (2 pls. and 6 figs.).

regarded as resulting from an arrest of development, frequently reproducing the form which the whole plant originally possessed. In many plants this youthful form disappears rapidly and at a very early period; while in others it remains for a very considerable time, according to the external conditions of life.

"Tan-disease" of Cherries.* — Dr. P. Sorauer describes a new disease of cherries similar to the well-known "tan-disease" of apples, which has made its appearance in Germany as the result of a wet summer. It manifests itself in the excessive development of the lenticels by the formation of fresh layers of cork beneath those previously in existence, and by a subsequent copious formation of gum. The latter appears to be the result of a great local accumulation of water and of formative substances.

Diseases of Trees.†—Dr. R. Hartig has published a second edition of his 'Text-book of the Diseases of Trees,' including those due to all causes:—external injury, unfavourable conditions of life, and the attacks of parasites, whether phanerogamic or cryptogamic. Among destructive fungi he describes in particular *Melampsora Tremulæ*, which attacks both the Scotch fir and the larch, *Phoma abietina* on the silver fir, *Trichosphæria parasitica* and *Herpotrichia nigra*, which are very destructive to forest-trees, *Pestalozzia Hartigii*, and many others.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Aluminium in Vascular Cryptogams.‡—Prof. A. H. Church finds aluminium to be a constant constituent of the ash of some species of *Lycopodium*, while it is entirely absent from others. Among other Vascular Cryptogams, the genera *Equisetum*, *Ophioglossum*, *Salvinia*, *Marsilea*, *Psilotum*, and *Selaginella* gave negative results; it was found only in the ash of some tree-ferns, but is an important constituent of the water-moss *Fontinalis antipyretica*. It occurs in combination with organic acids, and may serve to neutralize the acids produced in the plant.

Germination of the Megaspore of Isoetes.§—According to Mr. J. B. Farmer, the coat of the megaspore of *Isoetes lacustris* consists of six layers:—the epispore, derived from the epiplasm of the megasporange, a colourless, glassy, and brittle layer, whose surface is beset with numerous irregular prominences; the exospore, composed of three brown cuticularized layers; and the endospore, composed of two layers of cellulose. The protoplasm of the megaspore is remarkably granular, and contains a large quantity of starch and oil, and a sharply differentiated nucleus. The first indication of cell-division in the formation of the prothallium is the appearance of a very thin membrane of cellulose derived directly from the protoplasm, which cuts the spore into a basal and an apical portion; while the former for some time undergoes no change, the latter

* Bot. Ztg., xlvii. (1889) pp. 181–6.
† 'Lehrb. d. Baumkrankheiten,' 2 Aufl., 137 figs. and 1 coloured pl., Berlin, 1889. See Bot. Ztg., xlvii. (1889) p. 272.
‡ Proc. Roy. Soc. Lond., xliv. (1888) pp. 121–9.
§ Op. cit., xlv. (1889) pp. 306–8, and Ann. of Bot., iii. (1889) pp. 131–4.

is divided very rapidly into a number of cells whose arrangement can still be followed even in quite old prothallia. The rudiments of the archegones make their appearance very much as in Marattiaceæ; the neck being first formed by periclinal division, then the neck-canal-cell; and finally the ventral canal-cell is cut off from the oosphere, when the canal-cells thrust themselves between the neck-cells.

Antherozoids of Ferns.*—M. L. Guignard has investigated the mode of development of the antherozoids in a number of genera of ferns, viz. *Adiantum, Gymnogramme, Pteris, Pellea, Aspidium*, and *Asplenium* belonging to the Polypodiaceæ, *Osmunda* among the Osmundaceæ, and *Angiopteris* among the Marattiaceæ.

The processes are, in all essential points, identical with those in the Characeæ † and Muscineæ. The antherozoids are larger than those of the Muscineæ, and are provided with a larger number of cilia; they proceed from rounded or ovoid mother-cells. The nucleus transfers itself, before it becomes transformed into an antherozoid, from a central to a lateral position. The mature antherozoid consists of from two to three turns of the spiral; its anterior extremity has the form of a beak; this portion being comparatively thin, the posterior portion thicker; the latter carries, when the antherozoid escapes, a vesicle which contains starch-grains and the residue of the nutritive protoplasm. The formation of the cilia takes place at an early period; the hyaline layer of protoplasm which covers the outer surface of the nucleus developes into an annular band inclosing the granular protoplasm. This layer is more extensive than in the lower Cryptogams, corresponding to the greater number and length of the cilia. The formation of these latter commences at the anterior end of the antherozoid, and is rapidly completed along their whole length, which somewhat exceeds that of the adult body. They are inserted in a tuft on the anterior half of the first turn of the spiral.

Stem of Ferns.‡—M. Leclerc du Sablon describes the difference between the structure of the root and the stem in *Pteris aquilina*. These results agree in all essential points with those obtained by M. Gérard in *Asplenium striatum* and *A. cuneatum*. Near the base of the stem the smaller vessels of the wood lie towards the exterior, as in the root, but this arrangement is somewhat altered by the insertion of the leaves. The central cylinder of the stem is formed by a xylem-portion at the centre, a ring of phloem round the xylem, and a layer of pericycle round the phloem. Soon this structure is somewhat modified. Towards the centre of the xylem-portion phloem-elements appear, and this phloem gradually increases. In the stem there is then at the centre the phloem, then a ring of xylem, then a ring of phloem, then the pericycle. A comparison has been made between the stem of Ferns and that of *Auricula;* in all these plants the thickening of the stem is not effected by secondary formations, but by successive divisions of the central cylinder. The same general results were presented by other ferns,

Varieties in Ferns.§—Mr. E. J. Lowe has observed, in the case of *Scolopendrium*, that the same prothallium will sometimes produce two

* Comptes Rendus, cviii. (1889) pp. 464–6, and Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 71–8 (1 pl.).
† Cf. this Journal, *ante*, p. 417.
‡ Bull. Soc. Bot. France, xxxvi. (1889) pp. 12–4.
§ Ann. of Bot., iii. (1889) p. 129.

plants which both exhibit the same marked and identical variation in their character.

Rabenhorst's Cryptogamic Flora of Germany (Vascular Cryptogams).*—This volume of this important publication is now completed by the publication of parts 11–14. These include the completion of the Equisetaceæ, in which twelve species of *Equisetum* and a large number of varieties are very fully described, divided into the "phaneropora" and the "cryptopora." The isosporous Lycopodineæ include the two orders Lycopodiaceæ and Isoetaceæ, each with a single genus, *Lycopodium* and *Isoetes*, the former comprising six, the latter two species. Finally the Selaginellaceæ include the single genus *Selaginella* with three species. Throughout this most valuable work the descriptive letterpress and the woodcuts leave nothing to be desired.

Tubicaulis.†—Prof. G. Stenzel publishes a monograph of the species of fossil herbaceous ferns, several of them new, which may be referred to Corda's genus *Tubicaulis*, but which are now distributed through that genus, *Asterochlæna*, *Zygopteris*, and *Anachoropteris*. The genus *Tubicaulis* in its restricted sense now includes only *T. Solenites*, distinguished by its cylindrical central vascular bundle. In *Asterochlæna* the bundle is lobed in a radiate manner, and the leaf-stalk-bundles are ribbon-shaped in transverse sections. *Zygopteris* has a tubular central bundle filled with medullary parenchyme and with five projecting ridges, the leaf-bundles having a peculiar H-form in transverse section. A new species, *Z. scandens*, is described, the slender stems of which creep into the envelope of the root of *Psaronius*, where they carry on an epiphytic existence. The greater part of the leaves are reduced to short scales, while above each leaf, springing apparently from the stem, is a short cylindrical lateral shoot. *Anachoropteris* is distinguished by the convex form of the transverse section of the vascular bundles.

Muscineæ.

Leptotrichic Acid.‡—The glaucous appearance of *Leptotrichum glaucescens* is caused by a white scurfy coating, which protects it from the action of water like a coating of wax. Herr J. Amann finds this substance to be very soluble in ether, chloroform, or hot alcohol. From the acid solution in ether leptotrichic acid crystallizes out on evaporation in the form of prismatic needles. It is scarcely affected by concentrated sulphuric or hydrochloric acid, or by caustic alkalies in the cold. The author finds this substance present in the green parts of the moss to the extent of 13 per cent. of its weight, and believes it to be the first crystallizable substance as yet found in the Muscineæ.

Mosses from New Guinea.§—Herr A. Geheeb describes the mosses collected in New Guinea, mostly on the Fly river, by Bäuerlein, in Captain Evvill's expedition. Out of the twenty-seven species about eighteen are new, but belong to familiar genera.

* Luerssen, C., 'Die Farnpflanzen (Pteridiophyta),' 8vo, Leipzig, 1889, xii. and 906 pp. (228 figs.).

† Uhlworm u. Haenlein's Biblioth. Bot., 1889, Heft 12, 50 pp. and 7 pls.

‡ Bot. Centralbl., xxxvii. (1889) pp. 71–2.

§ Uhlworm u. Haenlein's Biblioth. Bot., 1889, Heft 13, 12 pp. and 8 pls.

Antherozoids of Hepaticæ and Mosses.*—In all the Hepaticæ examined, belonging to very different types of structure—*Pellia*, *Anthoceros*, *Frullania*, *Marchantia*, &c.—M. L. Guignard finds the mode of development of the antherozoids to agree in all important points. *Pellia epiphylla* may be taken as a type.

The mother-cells of the antherozoids have a discoid form, one side being flat and the other slightly convex; they remain attached in pairs by their flat faces until the maturity of the antherozoids, which are formed singly in each of them. In the formation of the antherozoid the nucleus of the mother-cell, at first central, moves to one side, and is covered only by a very thin layer of protoplasm. It now elongates greatly, and curves in a spiral manner; its anterior extremity, always very thin, is in close juxtaposition to the thick posterior extremity; finally the spiral attains three or four turns. The thin layer of protoplasm which covers the outer surface of the nucleus becomes a hyaline band which is continued as far as the opposite side, surrounding the granular protoplasm. From it are formed the two cilia which proceed from the anterior end of the antherozoid, and rapidly attain their full length, which is equivalent to that of the spiral. The granular protoplasm comprised in the spiral is gradually absorbed as the antherozoid developes; a very few traces only remain at the period of maturity. The differences observed in other Hepaticæ concern only the form and size of the mother-cells, and the length of the cilia compared to that of the spiral.

The processes of development in the Musci are completely analogous to those in the Hepaticæ. In *Sphagnum* the body of the mature antherozoid consists of only two turns of the spiral, of which the first is much the larger, and, when escaping from the mother-cell, carries with it a residue of protoplasm in the form of a vesicle inclosing some granulations and a small quantity of starch. The two cilia, inserted at the anterior extremity, which has somewhat the appearance of a button, are always rather longer than the body of the antherozoid.

The mode of formation of the antherozoids of the Muscineæ agrees therefore, in all essential respects, with that of the Characeæ.† It is the nucleus only which is transformed directly into the body of the antherozoid; the cilia being formed, at an early period, from a hyaline layer of protoplasm outside the nucleus. The spiral body is homogeneous and chromatic, except in the posterior portion, where it is somewhat less receptive to nuclear reagents. It is covered by a very delicate hyaline envelope.

Geotropism of the Rhizoids of Marchantia and Lunularia.‡—From a careful series of observations on the development of the rhizoids proceeding from the bulbils of *Marchantia* and *Lunularia*, Herr H. Haberlandt states that growth in length takes place exclusively in the cap-shaped apical portion of the rhizoid, where it is manifested with extraordinary energy. The geotropic curvature is not exhibited, as has been stated, in a zone of the rhizoid below this growing portion, but in the growing portion itself. Under the influence of geotropism the rhizoids never assume a vertical direction, but make an angle of from

* Comptes Rendus, cviii. (1889) pp. 463–4, and Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 63–70 (1 pl.).

† Cf. this Journal, *ante*, p. 417.

‡ Oesterr. Bot. Zeitschr., xxxix. (1889) pp. 93–8.

50° to 70° with the vertical. Neither in the growing nor in the mature portion of the rhizoid could the author detect the least evidence of any variation in the thickness of the cell-wall, or in the distribution of the protoplasm on the two sides of the growing organ.

Algæ.

Connection of the geographical distribution of Algæ with the chemical nature of the substratum.*—Sig. A. Piccone points out the argument in favour of the view that Algæ do not absorb nutriment through their organs of attachment derived from the fact that the same species will be found growing apparently indifferently under totally different circumstances. He gives a list of 17 species ordinarily rupicolous which are found not unfrequently attached to the shells of molluscs or growing epiphytically upon other sea-weeds, and of two species ordinarily fucicolous which he found attached to a variety of other sea-weeds belonging to the Florideæ and the Chlorosporeæ.

Algæ of the 'Gazelle' Expedition.†—The Algæ collected in this expedition have been worked out by Herr E. Askenasy, with the assistance of M. Bornet and Herren Grunow, Hariot, Moebius, and Nordstedt. The following new species are described:—Cyanophyceæ:—*Microchæte vitiensis*. Conjugatæ:—*Gymnozyga longicollis*. Confervaceæ:—*Anadyomene reticulata*. Characeæ:—*Nitella dualis*. Siphonocladaceæ:—*Halimeda macrophysa*, *Caulerpa delicatula*. Phæophyceæ:—*Ectocarpus Constanciæ*. Fucaceæ:—*Cystophyllum nothum*, *Sargassum pulchellum*, *S. Mauritianum*. Florideæ:—*Hildebrandtia Lecannellieri*, *Chantransia Naumannii*, *Rhabdonia decumbens*.

Dictyosphæria favulosa consists of large cells, 0·5–2 mm. in diameter, between which are several rows of smaller cells; the structure of the walls of the latter is very peculiar. Young plants have the form of a closed sac, resulting from the segmentation of large cells, containing numerous nuclei, starch-grains, and peculiar brown elliptical bodies. The structure of *Halimeda* is described in detail. Among the Mesoglœaceæ the author regards the genus *Myriocladia* as hardly sufficiently distinct from *Mesoglœa*. In *Galaxaura* (Chætangiaceæ) the structure recalls that of *Halimeda*. Straight branching medullary hyphæ send out branches at right angles which end in the cortical fibres. The only fructification observed consisted of cystocarps. In *Corynospora Wüllerstorfiana* (Ceramiaceæ) polyspores were observed closely resembling those of *Pleonosporium*. *Marchesettia spongioides* (Areschougiaceæ) the author regards as undoubtedly furnishing an example of symbiosis between a Floridea and a sponge. The species of sponge probably varies. The only reproductive organs observed were tetraspores.

Development of Tissues in Florideæ.‡—Prof. N. Wille gives more detailed illustrations of the six groups into which he divides the Florideæ, dependent on the mode of growth of the frond and the development of the different tissues.

* Notarisia, iv. (1889) pp. 667–71.

† Algen (Forschungsreise S.M.S. Gazelle), Th. 4, Botanik, Berlin, 1888, 58 pp. and 12 pls. See Bot. Centralbl., xxxvii. (1889) p. 112.

‡ Nova Acta K. Leop.-Carol. Akad., lii. (1888) pp. 49–100 (6 pls.). Cf. this Journal, 1886, p. 658.

Frond of Polysiphonia.* — Herr L. K. Rosenvinge contests the theory of Schwendener that the spiral arrangement of the "leaves" of *Polysiphonia* is brought about by contact of these organs with the axis which bears them. In *P. violacea* he found no such contact, even at the earliest period. The "leaves" of the lateral shoots of many species of *Polysiphonia* are from the first arranged in a regular sinistrodromal spiral not resulting from any contact.

The cells of many Florideæ are united by pores formed apparently at the same time as the walls which they perforate. In several species of *Polysiphonia*, especially in *P. violacea*, the author finds in addition, and in the pericentral cells, "secondary pores" formed in a very remarkable way. The young cell contains a rather large nucleus, which soon divides into two, the lower of which lies on the lower and outer angle of the cell. A small triangular piece of the cell containing this nucleus is now cut off by an oblique wall, and this segment passes through the underlying wall, and coalesces with the subjacent cell. Its nucleus passes into the underlying cell, but a fine strand of protoplasm remains uniting it with the protoplasm of the cell from which it was cut off; and the pores through which these strands pass are the secondary pores. The author compares this process with a similar one in the Hymenomycetes.

Apical cell of Lomentaria and Champia.†—According to Prof. N. Wille there is in *Lomentaria kaliformis* only a single apical cell, from which segments are cut off in different directions. This is to some extent at variance with the observations of Debray and others.‡ The branches are hollow with transverse diaphragms. The outer wall consists only of two primary layers, the outer of which afterwards gives rise to the small cells filled with endochrome. In older branches these cells expand into a connected layer outside the outermost primary layer. The inner of the two primary layers constitutes a conducting system; but the cells of this system originate by tangential division of young cells of the outer layer. In the centre of the apex is a large cell which has probably been formed from the apical cell of the outer layer by a division parallel to its base. This apical cell is polygonal, and from it are separated daughter-cells in six directions.

Prof. J. G. Agardh § agrees generally with the view of Wille that the cells of the outer layer in the frond of *Lomentaria* and *Champia* originate from the outer cells of the inner layers. These internal layers put out outwardly ramifications which form the outer parenchyme of the thallus, and inwardly ramifications which form the diaphragms.

Bulb of Laminaria bulbosa.‖—Mr. C. A. Barber has investigated the structure of the stem of this sea-weed, which differs from that of other species of the genus. It is characterized by the peculiar bulb-like enlargement of the base which is attached to the substratum by several successive circular rows of "hapteres," and by its bearing sporanges on the "bulb." While in other species of *Laminaria* the hapteres arise as

* Bot. Tidskr, xvii. (1888) pp. 1–19 (1 pl.). See Bot. Centralbl., xxviii. (1889) pp. 528, 529.
† Bot. Notiser, 1887, p. 252. See Bot. Centralbl., xxxvii. (1889) p. 420.
‡ Cf. this Journal, 1888, p. 265.
§ Ofv. K. Vetensk Akad. Förhandl., 1888, pp. 49–68.
‖ Ann. of Bot., iii. (1889) pp. 41–64 (2 pls.).

emergences, and appear in ascending order in more or less regular series, in *L. bulbosa*, they are developed on the bulb, the stalk, and the basal parts of the lamina. The stalk may be divided into five regions, viz.:— (1) the primary fixing-organ, (2) the bulb, (3) a flattened twisted portion, (4) a portion with flounced edges, and (5) a flat straight piece which passes upwards into the lamina. The principal purpose of the bulb appears to be the fixing of the plant to the sea-bottom. It also serves to produce sporanges; so that, if the rest of the plant is torn away by storms, there is still left in the bulb the power of assimilation and of reproduction. *L. bulbosa* is probably an advanced type, with a large amount of differentiation and complicated attempts at adaptation.

Contraction of the Chlorophyll-bands of Spirogyra.*—Herr H. de Vries finds that several species of *Spirogyra* (notably *S. communis* and *nitida*), when the filaments hibernate, have the chlorophyll-bands contracted; but that this is not the consequence of injury is shown by the continued turgidity of the cell and movement of the protoplasm-granules, as well as by the impermeability of the tonoplasts to eosin and plasmolytic reagents during the contraction. When the contraction of each separate band begins at one or at both ends, the bands simply break up into small portions which lie on the line of the original bands. But when, in a compound spiral, like that of *S. communis*, the middle coils contract, while the outer ones retain their original position, the cylindrical tonoplast becomes more or less deeply constricted in a variety of ways.

Variation in Desmids.†—M. E. De Wildeman describes and figures a number of varietal forms of species belonging to the genera *Micrasterias* and *Euastrum*, and believes that a large number of these variations are the result of reduplication or division, especially when this takes place before the half-cells have attained their full development. He considers also that it is impossible to ignore the existence of geographical races of the same species.

Spongocladia.‡—Messrs. G. Murray and L. A. Boodle referring to Marchesetti's observations § on the symbiotic relationship of a sponge and an alga in the case of *Marchesettia spongioides*, consider that this discovery confirms the probability of a similar phenomenon being presented also by *Spongocladia*.

Urospora.‖—Herr G. Woltke does not agree with Areschoug's later identification of his *Urospora mirabilis* with the genus *Hormiscia*, but regards it as constituting a distinct genus of Ulotrichaceæ. It grows on rocks which are occasionally sprinkled with salt water. The filament is unbranched, and consists of cylindrical thick-walled cells of very variable size and form. One or more basal cells, of greater length but smaller breadth, and destitute of chlorophyll, constitute a rhizoid. The green cells contain a single chromatophore which encloses a number of pyrenoids. The megazoospores are pear-shaped, with 4 cilia at their broader colourless rounded end, from $14 \cdot 5$ to $25\ \mu$ long, and from $5 \cdot 8$ to $9\ \mu$ broad, a large number being contained in a mother-cell, where

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 19–27 (1 pl.).
† Bull. Soc. R. Bot. Belgique, xxvi., part i., 1887 (1889) pp. 271 88 (1 pl.).
‡ Ann. of Bot., iii. (1889) pp. 129–31. Cf. this Journal, 1888, p. 1002.
§ Cf. this Journal, 1885, p. 282.
‖ Schrift. Neurussisch. Naturf. Gesell. Odessa, xii., 53 pp. and 2 pls. See Bot. Centralbl., xxxviii. (1889) p. 483.

they are formed by successive bipartitions. On germinating, the anterior colourless end developes into the rhizoid. Under unfavourable vital conditions *Urospora* forms resting-cells.

Chionyphe.*—According to Dr. G. B. de Toni, this genus of snow-Algæ proposed by Thienemann, is nothing but the protoneme of a moss, probably an *Andreæa* or *Bryum*. The genus *Kurzia* of Martens again, possibly consists of the very reduced leaves of a *Jungermannia*.

Crenacantha, previously identified by de Toni with *Bulbochæte*, he now regards as more probably belonging to the Cladophoraceæ, possibly near *Chloropteris* Mont.

Avrainvillea.†—Messrs. G. Murray and L. A. Boodle give a diagnosis and monograph of this tropical genus of Multinucleatæ, with which they identify *Rhipilia* and *Chlorodesmis*, placing it near to *Penicillus* and *Udotea*, from which it differs in the absence of any calcareous incrustation. Nine species are described, one of them new. The mature plant is, when not in a reproductive condition, almost absolutely non-cellular. The filaments are dichotomously branched, and are more or less interwoven, so as to form a stalked or sessile frond above, a mass of rhizoids below; the filaments are constricted, and very rarely septated, near their base. The protoplasm forms in most cases a rather thin parietal layer, through which are distributed the chlorophyll-grains and a very large number of nuclei, which are usually considerably larger than the chlorophyll-grains and much more granular. A yellowish or brownish colouring-matter is distributed through the protoplasm. The frond is always more or less flabelliform, and usually more or less felt-like in texture. The mode of reproduction was not observed. The authors suggest that the gigantic fossil siphoneous alga *Nematophycus*, from the Devonian, was possibly allied to *Avrainvillea*.

Cellulose-fibres of Caulerpa.‡—Herr F. Noll proposes a different explanation from that hitherto accepted for the fibres or bands of cellulose found within the greatly enlarged cell of *Caulerpa prolifera*. He shows, from various considerations, that their purpose cannot be the mechanical strengthening of the organism, and adduces evidence in favour of the view that they serve as a channel for the conveyance of nutrient substances more rapidly than this can take place through the protoplasm. They serve in fact the purpose of intervening a large surface between the internal protoplasm and the atmosphere, and may be compared with the external protuberances from the greatly enlarged cell of *Codium*. *Caulerpa* presents in this way the greatest differentiation of structure to be found in any non-cellular plant. The division into cells of the cellular plants must be regarded mainly as a contrivance for the same purpose, the easy transference of food-material, rather than as a splitting up into physiological units.

Volvox.§—Dr. L. Klein makes a further contribution to our knowledge of the morphology and life-history of this genus, his observations having been made chiefly on *V. aureus* Ehrb. (= *V. minor* Stein).

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 28–30.
† Journ. of Bot., xxvii. (1889) pp. 67–72, 97–101 (2 pls.).
‡ Arbeit. Bot. Inst. Würzburg, iv. (1888) pp. 459–65.
§ Jahrb. Wiss. Bot. (Pringsheim), xx. (1889) pp. 133–210 (3 pls.). Ber. Deutsch. Bot. Gesell., vi. (1888) Gen.-Vers.-Heft, xcix.–ci. Op. cit., vii. (1889) pp. 42–53 (1 pl.).

Both this species and *V. globator* vary remarkably in the size and number of the cells of which the colony is composed, in the size of the colony, and in the number of daughter-colonies, oospheres, oosperms, and bundles of antherozoids; while the size and form of the oosperms are nearly constant in both species. The two species are best distinguished by the form of the separate cells, and by the fact that the cells of *V. aureus* are always at a considerably greater distance from one another than those of *V. globator*. The separate cells of *V. aureus* are roundish when seen from the surface, and are connected with one another by extremely fine threads of protoplasm which are interrupted in the middle; while the much smaller cells of *V. globator* are angular in outline, and are connected by much stouter threads of protoplasm which are also interrupted. The colonies of *V. aureus* have very commonly an ellipsoidal or lemon-form. The protoplasts are invested by a thick gelatinous membrane which does not show the reactions of cellulose; the interior of the cœnobe is not filled with water, but with jelly.

When the daughter-families are being formed, the mother-colony remains passive. The movement of the colony is the result of rotation round an axis oblique to the path of motion. The young oospheres are connected with the adjacent vegetative cells by a number of connecting-threads. The bundles of antherozoids are formed from their mother-cells by radial division, just as the daughter-families are formed from the parthenogonids and germinating oosperms; the number of these bundles may amount, in the purely male colonies, which are known as *Sphærosira Volvox*, to over 1000; the antherozoids always escape in bundles, which are formed in succession, and only separate later and gradually.

Volvox aureus is neither purely non-sexual and diœcious, nor purely non-sexual and monœcious-proterogynous, but displays almost all possible combinations in the distribution of the sexes; Dr. Klein enumerates as many as ten of these combinations. The cœnobe must be regarded, from a physiological point of view, as an example of commensalism for the purpose of nutrition, and the author compares it to a bee-hive, where a small number of individuals, which are exclusively concerned with the reproduction of the species, live on the labour of the rest; the parthenogonids, the oospheres, and the bundles of antherozoids, are nourished by the vegetative cells. The reproductive organs always lie in the part of the colony which is posterior when in movement.

The alternation in the appearance of the sexual organs coincides with the changes of the seasons. In the spring there are found chiefly non-sexual or purely diœcious colonies, in the summer antherozoids only in otherwise vegetative colonies, in the late summer and autumn also the monœcious-proterogynous families, and vegetative colonies. The alternation of generations may close either, as is usually the case, with diœcious purely sexual, or with monœcious-proterogynous colonies.

From considerations derived from the history of development, Dr. Klein regards the bundle of antherozoids of *Volvox* not as an antherid, but as a male colony, and as homologous with an entire cœnobe; each antherozoid invested in its envelope of mucilage is an antherid, and homologous with an oogone and its single oosphere. It is possible to have three generations, one inclosed within another, and all fully developed.

Nematophyton.*—From a careful examination of the remains of the fossil forms known as *Prototaxites* and *Nematophyton* (*Nematophycus* Carruth.), from the Devonian strata of Gaspé, including those of a new species, Sir W. Dawson and Prof. D. P. Penhallow confirm the conclusions of Carruthers, that they are the remains of a gigantic alga probably nearly allied to the Laminariaceæ.

Fungi.

Fungus-pigments.†—Herr W. Zopf has examined the composition and properties of a number of pigments obtained from Fungi, Myxomycetes, and Schizomycetes, of which the following particulars are now given.

Several fungi contain a pigment nearly allied to gamboge. It was obtained especially from *Polyporus hispidus*, which is not uncommon on trees. It consists of two substances, one a yellow resin insoluble in water, the other a soluble yellow-green pigment with acid properties. The chemical properties of the former substance are given in detail, agreeing closely with those of that obtained from *Garcinia*.

From the fructification of several species of *Thelephora* a pigment was obtained, which is a mixture of at least three different substances,—thelephoric acid, of a beautiful red colour, crystallizing in blue crystals; a yellow uncrystallizable acid, soluble in water; and a yellow resin. They are found both permeating the cell-membranes and as products of excretion, and the last also as a cell-content.

The beautiful red colour of *Trametes cinnabarina* is due to a mixture of a substance crystallizing in beautiful cinnabar-red crystals, and of a resin. The former the author proposes to call xantho-trametin.

In *Bacterium egregium*, and possibly also in other Schizomycetes and Myxomycetes, Herr Zopf finds a lipochrome or oil-pigment, analogous to the anthocyan of flowering plants, the formation of which is not dependent on the presence of light.

Musk-fungus.‡—Dr. S. Kitasato has found in hay infusions a mould-fungus which gave out a peculiar odour of musk. He was able to cultivate it on extract of meat-peptone-gelatin, agar-agar, bread, potatoes, rice, and in a number of infusions. On a solid substratum the mycele was at first white, afterwards reddish, and finally scarlet, with cockscomb-like projections, giving out a distinct odour of musk.

The development of the mycele can be readily followed out under the Microscope. It consists at first of crescent- or sickle-shaped bodies, 7–13 μ long, and 1–1·5 μ broad at the broadest part, with a dividing-line in the middle. At an ordinary temperature of 15–18° C., after about 12–15 hours, a germinating-tube proceeds out of each end of the crescent-shaped bodies, soon attaining a considerable length, and putting out protuberances, which develope into the unilateral branches which give the comb-like appearance to the mature form. From the filaments are finally produced crescent-shaped protuberances which become detached and remain after the rest of the filament has perished.

On a solid substratum the filaments become septated into short segments, which form oidium-like bodies of a sausage-shape. These

* Trans. Roy. Soc. Canada, vi. 1888 (1889) pp. 27–47 (2 pls.).
† Bot. Ztg., xlvii. (1889) pp. 54–61, 69–81, 85–92 (1 pl.).
‡ Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 365–9 (5 figs.).

round themselves off at the two ends, which become separated from one another, and then act as true arthrospores, a germinating-filament proceeding from each. The fungus is a *Fusisporium*, and the author calls it *F. moschatum*. It appears to have no pathogenous properties.

New Entomophthoraceæ.*—M. A. Giard identifies *Empusa Freseniana* Nowak. (*Triplosporium Fresenii* Thaxt.), parasitic on *Aphis Mali*, with *Neozygites Aphidis*, hitherto placed among the Gregarinidæ. The genus *Basidiobolus* of Eidam he regards as nothing but a phase of development of a particular group of Entomophthoraceæ parasitic on flies. The two kinds of spore of *B. ranarum* occur also in *Entomophthora Calliphoræ*. The former is found on the excrement of frogs, lizards, &c., which feed largely on *Calliphora*. It is probable that the spores germinate in the digestive tube of the fly, and attain their full development only in the excrement of the animal which devours it, where it puts out hyphæ and conids and a small number of hypnospores.

The following new species are described:—*Entomophthora saccharina*, parasitic on the larva of *Euchelia Jacobææ; E. Plusiæ*, on the larva of *Plusia gamma; Metarhizium Chrysorrheæ*, on the larva of *Liparis Chrysorrhea; M. ? Leptophyei*, on a rare orthopter, *Leptophyes punctatissima*.

Urophlyctis Kriegeana sp. n.†—Herr P. Magnus finds this new species of Chytridiaceæ forming galls on *Carum Carui*. Hyphæ belonging to the mycele conjugate by means of a short canal, the contents of one of the hyphæ flowing through this canal into the other, which then developes into a brown resting-cell, or more probably resting zoosporange, with smooth wall. The central chamber of mature galls contains a number of these resting-cells, attached to which are often to be seen the membranes of the empty conjugating-cells.

Elæomyces, a new type of Fungi.‡—Herr O. Kirchner has found, in a sample of oil of poppies, a remarkable fungus, to which he has given the name *Elæomyces olei*. When completely immersed in the oil, the somewhat elongated cells appear to multiply themselves only by a kind of torulose sprouting, similar to that of *Saccharomyces* or *Mucor;* but, when more or less completely exposed to the air, the development is totally different. The cells lose their linear connection with one another, round themselves off, and unite into an irregularly outlined agglomeration of cells. Of these cells the greater number gradually lose their contents and perish, while a few increase in size, acquire a thicker wall and denser granular contents, finally becoming spores of a somewhat lemon-shaped form, the germination of which, however, was not followed out. The author regards the formation of the "spores" as a kind of conjugation, which may possibly establish the systematic position of *Elæomyces* to be among the Zygomycetes, near the Ustilagineæ.

Synthesis of Physcia parietina.§—M. G. Bonnier sowed spores of *Physcia parietina* among about 40 cells of *Protococcus viridis*. He was thus able to observe the first differentiation of the filaments which proceed from the spores, and their envelopment of the algal cells. He could watch the formation of the pseudo-parenchyme, and the mode in

* CR. Soc. de Biol., Nov. 24, 1888. See Morot's Journ. de Bot., iii. (1889) Rev. Bibl., p. iii.

† SB. Ges. Naturf. Freunde, 1888, pp. 100-4.

‡ Ber. Deutsch. Bot. Gesell., vi. (1888) Gen.-Vers.-Heft, pp. ci.-civ. (1 pl.).

§ Comptes Rendus cvii. (1888) pp. 142-4.

which the algal cells gradually develope into the gonids of the lichen. All the phases of development, from the germination of the spores to the formation of a thallus identical with that found in nature, were studied in detail.

New development of Ephelis.* — Dr. M. C. Cooke and Mr. G. Massee describe a new development of *Ephelis* which was discovered on *Panicum palmifolium*. As in other cases of proved dimorphism, the stylosporous form and the ascigerous form are still retained separately under their respective genera; so in this case the authors describe the new *Ephelis* under the name *E. trinitensis;* and other specimens were found on the same host, which carried the history forward much further. Instead of the discoid cup-like receptacles exhibited by *Ephelis*, each of them was transformed, or was in the course of a transformation, into a basin-shaped capitulum of 1 to 1½ mm. diameter, raised upon a peduncle two or three times its length; the transformation being brought about by the replacing of the concave surface of the cups by a convex one, and the subsequent elevation of this surface on a stalk. In the authors' opinion there is very little doubt that this fungus must be referred to the genus *Balansia*, and they describe a new species under the name of *B. trinitensis*. The difference between this species and *Balansia claviceps* Speg. are then pointed out, and the paper concludes with some remarks on the morphology of *Ephelis*.

Disease of Chestnut-trees.†—M. C. Roumeguère describes a disease which has caused great ravages among the chestnut-trees in Aveyron, Var, Dordogne, and Haute-Vienne. It is caused by the fungus *Phyllosticta maculiformis*, and was described by Prof. Saccardo in 1881. *Phyllosticta* always developes on the under side of the leaf, and forms small groups of black peritheces; these peritheces dehisce by a pore, and at maturity emit cylindrical sporules which are distributed far and wide by the wind, and germinate in the spring of the following year. *Phyllosticta* is supposed to be one of the forms of the well-known *Sphæria maculiformis*.

Life-history of Macrosporium parasiticum.‡—Mr. Kingo Miyabe describes the life-history of *Macrosporium parasiticum* Thüm., the material being found on onion-plants in Bermuda.

The following is a recapitulation of the principal results obtained:—(1) The ascosporous stage of *M. parasiticum* is the common *Pleospora herbarum* (Pers.) Rabenh. (2) *M. parasiticum* is identical with *M. Sarcinula* Berk. (3) *Pleospora herbarum* is decidedly a facultative parasite. (4) There are only two stages in the development-cycle of *P. herbarum*, the ascosporous and the *Sarcinula* stage. (5) The presence of pycnids in *P. herbarum* is very doubtful, and they may have entirely disappeared from its cycle of development. (6) No *Alternaria*-form belongs to *P. herbarum*. (7) The formation of the perithece is purely non-sexual. (8) No Woronin's hyphæ or similar spiral processes are found in the peritheces before the formation of asci and paraphyses. The asci and paraphyses are produced from the same short chains of parenchymatous cells, which are formed by elongation and division of the pre-existing cellular groups of parenchymatous nature filled with

* Ann. of Bot., iii. (1889) pp. 33–9 (1 pl.). † Rev. Mycol., xi. (1889) pp. 34–5.
‡ Ann. of Bot., iii. (1889) pp. 1–24 (2 pls.).

highly refractive contents, and situated generally in a central portion of the perithece.

American "Bitter-rot."*—According to M. F. Cavara, the fungus which causes the vine-disease, known in America as "bitter-rot," is not *Coniothyrium diplodiella*, but must be placed in the genus *Melanconium*, where it may be distinguished as *M. fuligineum*. It is the only species of the genus at present known which is parasitic on the fruit of a dicotyledon.

Cladosporium herbarum.†—M. J. Costantin gives the details of some researches on *Cladosporium herbarum*, and also on *Alternaria tenuis*. He gives several reasons for thinking that there exists a relationship between *Cladosporium* and *Alternaria*, and states that the primitive opinion of Tulasne is confirmed, and that the polymorphism of *Cladosporium* is even greater than that savant supposed.

M. E. Laurent ‡ states that this fungus may present, in addition to its normal form, either of the following:—(1) *Penicillium cladosporioides* Fres., or (2) *Dematium pullulans* De Bary, or (3) the white "levure" of Pasteur, or (4) the *Fumago*-form. The author proposes also a reform in the terminology applied to Hymenomycetes, to meet the progress which has taken place recently.

Microscopic twining Fungus.§—Dr. R. Ludwig describes a minute fungus parasitic on *Bertya rotundifolia* (Euphorbiaceæ) from Kangaroo Island, South Australia. The leaves of the host are covered with tufts of hairs, which are attacked by the fungus, the twining stems of which completely surround and embrace the hairs, always turning to the left. It is probably nearly allied to *Fumago* and *Pleospora*, and is apparently genetically connected with moniliform toruloid chains of cells on the upper side of the leaf, belonging to a fungus named by Saccardo *Heterobotrys paradoxa*. The only mode of propagation described is by non-sexual spores.

Heterospory of Gymnosporangium.‖—Dr. P. Dietel makes the interesting observation that several species of *Gymnosporangium* produce two kinds of teleutospore. The ordinary thick-walled brownish form is produced only in the outer part of the fructification; these are only slightly constricted at the line of junction of the merispores, which remain closely connected with one another. The second kind of teleutospore has a very thin colourless membrane, and consists of only two merispores which separate very readily from one another owing to a deep constriction at the line of meeting. They are imbedded in mucilage, and contain an orange-yellow cell-content. Although these thin-walled teleutospores do not differ in morphological value from the thick-walled ones, they appear biologically to represent the uredospores of other Uredineæ. They have been observed in *Gymnosporangium clavariæforme, juniperinum, Sabinæ, macropus, clavipes, globosum*, and *biseptatum*.

Mildew of the Apple. ¶—The mildew of the apple-tree has been attributed by different writers to various fungi, *Phyllactinia suffulta*,

* Ist. Bot. R. Univ. Pavia, 1888, 4 pp. See Bull. Soc. Bot. France, xxxvi. (1889) Rev. Bibl., p. 20.

† Journ. de Bot. (Morot), iii. (1889) pp. 1–3.

‡ Rev. Mycol., xi. (1889) pp. 105–6.

§ Ver. Naturfr. Greiz, Jan. 1889. See Bot. Centralbl., xxxvii. (1889) p. 339.

‖ Hedwigia, xxviii. (1889) pp. 19–23, 99–103.

¶ T. c., pp. 8–12.

several species of *Erysiphe*, and *Podosphæra Kunzei*. Dr. P. Sorauer finds the white tufts on the upper side of the leaf to consist of the conidial form of a fungus closely allied to *Sphærotheca Castagnei*, and which he describes as f. *Mali* of that species. The peritheces were not found on the leaves themselves, but on the leaf-stalks or young branches.

Uredineæ of Pinus Strobus.*—Herr H. Klebahn finds very great injury inflicted on plantations of the Weymouth pine by two parasitic fungi belonging to the Uredineæ, *Peridermium Strobi* and *P. Pini corticola*. Experiments were made to determine the teleuto- and uredo-spore forms that are genetically connected with the æcidio-form which attacks the pines, especially those found on various species of *Ribes;* and the author claims to have established the connection between *Peridermium Strobi* on *Pinus Strobus*, *Lambertiana*, and *monticola*, and *Cronartium ribicola* on *Ribes aureum*, *nigrum*, *rubrum*, and *sanguineum*. Æcidiospores of *P. Strobi* sown on leaves of *Cynanchum Vincetoxicum* produced no result. The "spermogones" of *P. Strobi* are also described; the author is unable to assign any sexual function to the "spermatia." He was not able definitely to determine the genetic connection between *Peridermium Pini corticola* and *Cronartium asclepiadeum*, though he considers it probable.

Coleopuccinia.†—M. N. Patouillard describes a new genus which comes between *Gymnosporangium* and *Uropyxis*, from Yunnan, the teleutospores of which germinate on *Amelanchier*. This parasite has spores of the same form as those of a *Puccinia ;* they are composed of two superposed cells, the lower being supported by a colourless stipe of the same length as the cell. Each of these spores is inclosed in a cylindrical sheath which is closed both above and below, and is colourless and gelatinous. The author concludes by giving a diagnosis of this new genus, to which he has given the name *Coleopuccinia*, on account of the sheath, and to denote its affinity to *Puccinia*.

Tulasnella, Prototremella, and Pachysterigma.‡—M. J. Costantin states that Tulasne many years ago described a fungus having the external characters of *Corticium incarnatum*, but differing in the basids bearing swollen sterigmata. Not attributing very much importance to this, he made a variety *pinicola*. In 1888 the preceding was described as a genus by three separate authors; these three genera are *Tulasnella* Schroet., *Prototremella* Pat., and *Pachysterigma* Bref., Istv., and Olsen. *Tulasnella* being the oldest name, ought to be preserved. It represents somewhat of a transition between the Hypochnaceæ and Dacryomycetes, approaching the former in the disjointed hymenium and aspect of *Corticium*, and the latter in the swollen sterigmata.

Phosphorescence of Agaricus olearius.§—According to Sig. U. Martelli, the phosphorescence of this fungus is not increased by a rise in temperature, nor by immersion in oxygen; in carbonic acid it gradually dies away, and disappears entirely at a temperature of 90° C. Every separate particle of the lamellæ is endowed with luminous properties; for, if any point of a lamella is touched, all the other lamellæ at once become luminous on both sides. The author considers that the phos-

* Ber. Deutsch. Bot. Gesell., vi. (1888) Gen.-Vers.-Heft, pp. xlv.-lv.
† Rev. Mycol., xi. (1889) pp. 35-6.
‡ Journ. de Bot. (Morot), iii. (1889) pp. 59-60.
§ Rev. Mycol., xi. (1889) pp. 97-9. Cf. this Journal, *ante*, p. 426.

phorescence has nothing to do with the process of reproduction, and that combustion is an effect rather than the cause of the phenomenon.

Phosphorescent Mushroom.*—Mr. G. F. Atkinson finds that the hymenium and a portion of the hymenophore directly adjacent of *Agaricus* (*Clitocybe*) *illudens* Schw. emit a phosphorescent light. Very young plants were also phosphorescent, though not so bright as when mature.

Poroptyche, a new genus of Polyporeæ.†—G. Ritter v. Beck gives the following diagnosis of a new genus represented by *Poroptyche candida*, found on dry calcareous soil. Fungus resupinato-expansus, in margine definito et sursum accrescens, in tota superficie poriferus, subtus mycelii ramis funiformibus solo indefinito sed arcte affixus. Poræ in margine primum foveatæ rotundæ, mox magis concavatæ, lobis varie accrescentibus tortuosæ et labyrinthiformes, sæpe clausæ, serius stroma poris numerosissimis irregulariter perforatum, et in superficie poris apertis præditum formantes. Hymenium poros induens. Basidia clavata, in stipitibus brevibus sporas 4 ellipsoideas hyalinas fingentia. Cystidia nulla.

Mycose on the Sporange of Mosses.‡—M. Amann describes a fungus which attacks the sporange of mosses and envelopes the young spores in numerous ramifications, arresting their development, and depriving them of chlorophyll, and finally agglomerating them into a compact mass which is incapable of germination.

Protophyta.

a. Schizophyceæ.

Peroniella, a New Genus of Schizophyceæ.§—Dr. C. Gobi finds, attached to the gelatinous envelope of *Hyalotheca mucosa*, an organism to which he gives the name *Peroniella Hyalothecæ*, and which he places among the Chlorophyceæ near to *Sciadium* and *Ophiocytium*. It consists of a single cell, at first ovoid or pear-shaped, but afterwards becoming spherical, fixed to the gelatinous sheath of the desmid by an elongated pedicel. The contents of the cell break up into seven or eight uniciliated zoospores. The vegetative cell also becomes encysted, by simple thickening of its cell-wall, and contraction of its protoplasm.

Stomatochytrium, a new genus of Endophytic Protococcaceæ.‖—Dr. D. D. Cunningham describes, under the name *Stomatochytrium Limnanthemi*, an endophytic green protophyte found in the stomates of the upper surface of the leaf of *Limnanthemum indicum*, resembling *Chlorochytrium Lemnæ* in its mode of life. It produces zoospores (zoogametes), which conjugate in the ordinary way, the zygosperms coming to rest after a period of swarming; but no germination was observed either of the zoospores or of the zygosperms. One point in which the genus is stated to differ from *Chlorochytrium* is that the zoospores are set free within the zoosporange. It is, like *Chlorochytrium*, not a true parasite, but an endophyte.

* Bot. Gazette, xiv. (1889) p. 19.
† Verhandl. K. K. Zool.-Bot. Gesell. Wien, 1888, pp. 657–8 (3 figs.).
‡ Rev. Bryol., xvi. (1889) p. 13.
§ Scripta Botanica, i. (1887) 1 pl. See Bull. Soc. Bot. France, xxxvi. (1889) Rev. Bibl., p. 6.
‖ Scient. Mem. by medical officers of the army of India, part iii. 1888, pp. 33–40.

Tetraedron.*—Prof. A. Hansgirg revises his monograph of this genus of Algæ, enumerating now twenty-seven species, arranged under the four subgenera *Polyedrium*, *Closteridium*, *Pseudostaurastrum*, and *Thamniastrum*, the first of these again consisting of two sections, Eupolyedrium and Cerasterias.

Movements of Diatoms and Oscillaria.†—According to the observations of Mr. W. A. Terry, the same species of diatom always occupies the same position while in motion. Thus *Stauroneis acuta* always travels with the valves vertical, showing the broad hoop or band and the edges of the valves, as also do several species of *Pinnularia* and *Surirella;* while *Stauroneis phenicenteron* travels with the valves horizontal, showing one uppermost, as also do several species of *Pinnularia*, *Surirella*, and all the species of *Pleurosigma*. The maximum rate of speed of diatoms is stated to be a distance of about their own length in two seconds.

The movements of *Oscillaria* cannot be explained, in the author's opinion, by movements of the protoplasm, inasmuch as this is inclosed in a rigid sheath. The proper motion appears to be an onward spiral movement forward and backward in the direction of the length of the filament, showing a striking resemblance to the motion of diatoms, and probably produced in a similar manner. The waving and nodding movements are always caused by the elasticity of the filament springing back to regain its normal position while working itself free from obstructions.

Valve of Pleurosigma.‡—Mr. T. F. Smith claims to have determined that the valve of *Pleurosigma formosum* consists of several layers of structure; the same is also true of *P. decorum*, *balticum*, and *angulatum*, and probably of other species of the genus. He recognizes three types of valve-structure in *Pleurosigma*, viz.:—(1) a valve composed of two layers of square grating, as *P. balticum;* (2) a valve with two layers of grating, with secondary markings placed diagonally, as *P. formosum;* and (3) a valve with two layers of net-like structure, as *P. angulatum*; and it is probable that all the species may be referred to one or other of these types.

Fossil Marine Diatoms.§—Mr. C. H. Kain and Mr. E. A. Schultze describe a remarkable fossil marine diatomaceous deposit from Atlantic City, New Jersey, which includes also a few fresh-water forms. Several new species are described, including possibly the type of a new genus.

Synedra pulchella Ktz., var. abnormis.‖—Under this name Sig. L. Macchiati describes a remarkable form of this pleomorphic diatom, agreeing with the type-form in the presence of a "definite annular pseudo-nodule" or "median circle," but characterized by a singular regular constriction near one end of the frond. The author proposes a rearrangement of the species included in the genus, depending on the fineness of the striation, and would separate the varieties *macrocephala* Grun. and *naviculacea* Grun. as distinct species.

* Hedwigia, xxviii. (1889) pp. 17–9. Cf. this Journal, 1888, p. 1013.
† Amer. Micr. Journ., x. (1889) pp. 81–3.
‡ Journ. Quek. Micr. Club, iii. (1889) pp. 301–7 (1 pl.).
§ Bull. Torrey Bot. Club, xvi. (1889) pp. 71–6 (1 pl.).
‖ Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 263–7 (2 figs.).

Classification of Cyanophyceæ.*—Dr. A. Hansgirg supplements his scheme of classification of the Myxophyceæ (Cyanophyceæ) by a few additional details, and adds descriptions of a new species *Cyanoderma* (*Myxoderma*) *rivulare*.

Parasitism of Nostoc.†—In reference to the observations of Frank ‡ on the power of plants to absorb free nitrogen from the atmosphere, Prof. K. Prantl suggests that this may be the function of the colonies of *Nostoc* or *Anabæna* so frequently found in cavities in the leaves of *Blasia*, *Anthoceros*, *Azolla*, *Gunnera*, *Cycas*, &c., thus serving to help in the nutrition of the host-plant. The same also may be the purpose of the Schizophyceæ belonging to these genera which enter into the composition of *Collema* and other large lichens.

β. Schizomycetes.

Morphology and Physiology of the Sulphur Bacteria.§—The first volume of his work on Bacteria Dr. T. Winogradsky devotes to the Sulphur-bacteria.

In a short introduction the author discusses the views of Ray Lankester, Warming, Zopf, and Cohn, who have expressed opinions for or against the pleomorphism of these organisms. After reviewing the various sulphur-bacteria, he decides that all the forms are distinct species, and are not pleomorphic organisms, and that all the forms included by Lankester, Zopf, and Warming can be sharply separated from one another.

Thus *Cladothrix dichotoma* developes in quite a simple manner; the spirilla, zooglœæ, &c., which Zopf has connected together are independent organisms; and this is the case with leptothrix and others. In conclusion, the author shows that the last support of the doctrine of pleomorphism has been removed, and that Cohn's classification of the species was correct.

Prof. A. Hansgirg, ‖ on the other hand, regards the sulphur-bacteria described by Winogradsky as forms, developed under special conditions, of already known genera and species. At all events, as far as the genera are concerned, he identifies Winogradsky's *Thiotrix* with Borzì's *Ophryothrix*, *Thiosarcina* with *Sarcina*, *Thiopedia* with *Lampropedia*, and *Thiospirillum* with *Spirillum*. *Thiopolycoccus*, *Thiocapsa*, and *Thiocystis* must also probably be sunk in corresponding genera previously described.

Bacteria which produce Sulphuretted Hydrogen.¶—Dr. Holschewnikoff, in a somewhat diffuse paper on the formation of H_2S by bacteria, gives the result of a few experiments made with two bacteria, called *Proteus sulphureus* and *Bacterium sulphureum*.

The former appears to closely resemble *Proteus vulgaris* Hauser, even if it be not identical with it. The latter, which was isolated from some reservoir mud, consists of rodlets with rounded ends, and with a length of $1 \cdot 6$–$2 \cdot 4$ μ, and breadth of $0 \cdot 5$ μ. In the former aerobic

* Notarisia, iv. (1889) pp. 656–8. Cf. this Journal, *ante*, p. 102.

† Hedwigia, xxviii. (1889) pp. 135–6.

‡ Cf. this Journal, *ante*, p. 412.

§ 'Beiträge zur Morphologie und Physiologie der Bacterien,' 8vo, vol. i., Leipzig, 1888, vi. and 120 pp., 4 pls. Cf. this Journal, 1887, p. 1007.

‖ Bot. Centralbl., xxxvii. (1889) pp. 413–4.

¶ Ann. de Micrographie, ii. (1889) pp. 257–74.

characters predominated, in the latter anaerobic. The sulphuretted hydrogen was detected by means of slips of filter-paper soaked in a solution of alkaline acetate of lead.

The first series of experiments were made with eggs; the white and yolk being used, both raw and cooked. H_2S was produced under all circumstances, but in varying quantities. Besides eggs, blood-serum and peptonized bouillon were employed, also with production of H_2S. In milk and sterilized casein no gas was developed. Hence the author infers that the cultivation medium seems to exert the decisive action, and not the presence or absence of oxygen.

Experiments with sterilized urine showed that *B. sulphureum* produced H_2S, but *Proteus sulphureus* failed to do so.

The addition of 0·5–3 per cent. of grape and milk sugars to peptonized broth prevented the formation of H_2S; hence the same microbe can effect a putrefaction which, according to the nature of the cultivation-medium, is with or without odour.

Experiments with certain sulphur salts, as sulphates and sulphocyanates, failed, but positive results were obtained from a 0·5 per cent. solution of hyposulphate of soda in the presence of air, with *Proteus sulphureus;* while *B. sulphureum* could only do so in the absence of air.

The last series of experiments were devoted to testing the assertion of Duclaux that the so-called aerobic fermentations are truly anaerobic. Three flasks of bouillon were taken; in one the surface was covered with oil, in the second the neck was merely plugged with cotton-wool, in the third arrangements were made to aerate the bouillon during the experiment. From the results of these experiments the author concludes that aerobiosis and anaerobiosis do not count for everything, but that the ultimate causes are to be sought for in the specific qualities of protoplasm.

Bacillus of Leprosy.*—Dr. C. Q. Jackson finds that the microscopical character and general morphology of *Bacillus lepræ* greatly resemble *B. tuberculosis,* but a point of difference is to be noted in that the bacilli of tubercle are not motile, while some of those of leprosy are. Inoculation with *B. tuberculosis* readily produces a characteristic definitely tubercular lesion, but the *Bacillus* of leprosy is difficult to inoculate in the lower animals, and in Man appears to require a certain predisposing condition. *B. lepræ* stains more easily than *B. tuberculosis,* though the same staining processes and reactions are applicable to both.

Vaccinal Properties of Microbes.†—M. A. Chauveau has, since 1884, been engaged in cultivating successive generations of *Bacillus anthracis* under a pressure of about nine atmospheres. He has thus succeeded in diminishing considerably its virulence, and in making it harmless to the sheep. Taking two infusions, one of which (A) was rather less powerful than the other (B), M. Chauveau has found that the first generation of A, after cultivation in compressed oxygen, was completely devoid of any pathogenic power; and successive generations, cultivated under normal conditions, gave also innocuous microbes. B had to be submitted for two generations to the increased pressure of oxygen before it lost its pathogenic powers.

In neither case, however, was there any change in the form of the

* Proc. Amer. Soc. Micr., x. (1888) pp. 119–27.
† Comptes Rendus, cviii. (1889) pp. 319–24, 379–85.

Bacillus or in its vegetative power, nor was there any loss of vaccinal effect. Still more remarkable, however, is the result of cultivating these innocuous microbes in cultivations only feebly nutrient or under a low pressure, for these recover their toxic powers on small animals; it remains to be seen whether they cannot be cultivated so as to injure sheep and oxen.

Hueppe's Bacteriology.*—Dr. F. Hueppe has recently published the fourth edition of his work on the methods of examining Bacteria. The present edition has been revised and improved throughout, and also much enlarged. It contains 434 pages, 2 coloured plates, and 68 wood engravings. It is divided into two parts, which respectively deal with the microscopical and experimental technique of the subject. It seems to contain all the necessary information brought up to date.

Tuberculous Infection of the Fowl-embryo.†—Prof. A. Mafucci gives the following account of an experiment made on hens' eggs by inoculating them with fowl-tubercle.

A cultivation from fowl-tubercle was first made on calf's blood-serum, and afterwards mixed with sterilized meat-broth. On June 28, 1888, a hen and a guinea-pig were inoculated for control purposes, and at the same time eighteen eggs, which were thereupon put under a brooding hen for incubation.

The guinea-pig died of tuberculosis in 40 days, and the hen in two and a half months. On July 17 eight chicks came out; of the rest of the eggs some had not been fertilized, and the others had become rotten. One showed a dead embryo, but this gave no evidence of tubercle or bacilli. The eight chicks were all small and delicate but active, except one, which died 36 hours after hatching out. Careful examination failed to reveal tubercle bacilli, though some spherical bodies were found among the liver-cells. The second chick died 20 days after hatching, and was much emaciated. Microscopical examination showed tubercle bacilli in nodules in the liver. The third chick died 32 days after hatching, presenting similar appearances to the last; the fourth chick in 40 days, similar to last; the fifth in 42 days, the most emaciated of the series; no naked-eye appearances, but microscopical tubercles in liver, lungs, kidneys, stomach, and intestine. The sixth died in 47 days; tubercles in liver, lungs, and lymphatic elements. The seventh died 78 days after hatching; tubercles evident to naked eye in lungs and liver. The eighth died four and a half months after hatching; was emaciated and poorly developed in comparison to healthy chicks born at the same time. There were malformations of the skeleton in the sternum, vertebral column, pelvis, beading of the costal cartilage, in fact all the signs of rickets. The liver and lungs showed tubercles, many of which were caseous, and of course bacilli were found on microscopical examination.

The only inference the author permits himself to draw from the foregoing very interesting experiments is that the tubercle bacillus of fowls, having penetrated the embryo, is not destroyed, but remains viable, and while not absolutely preventing the development of the embryo, produces its serious effects at a later stage. But in order to obtain correct information as to when and how the morbid process is set up,

* 8vo, Wiesbaden, 1889.

† Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 237-41.

the eggs must be opened from the first day of incubation up to the time of the hatching of the chicks, and the albumen as well as the organs and blood of the embryo examined. In this way the phases in the development of the tubercle bacillus and the time of its penetration into the embryonic tissue may be ascertained.

The author further expresses the opinion that the virus infects the embryo through the area vasculosa, which picks it up and passes it on to the liver, for this is the first point at which its effects are perceived. The lung affection is subsequent to that of the liver, for it probably does not take place through the amniotic fluid swallowed by the embryos, since in these the digestive tract is not affected in the same way as it is in the adult.

Bacillus murisepticus pleomorphus, a new pathogenic Schizomycete.*—Dr. J. Karlinski has isolated from the pus of an abscess on the lower part of a thigh, and also from that found in a case of puerperal septicæmia, a bacterium which has certain resemblances to Hauser's *Proteus*. It appears under all the various shapes characteristic of Schizomycetes generally, ranging from cocci to spirilla. Its most constant form is a rodlet about $2\frac{1}{2}$ times as long as broad, and these are frequently seen in pairs. The longer forms are motile, and the shorter possess a tendency to form zooglœa masses. The bacillus was cultivated on the usual media, and seems to thrive better on gelatin, which it liquefies, than on agar.

White mice inoculated with pure cultivations rapidly die, the organ most affected being the spleen, which is much enlarged and almost diffluent. White rats, guinea-pigs, rabbits, and dogs were also inoculated, but showed themselves less sensitive, though guinea-pigs and rabbits died if injected directly in a blood-vessel. Frogs injected in the dorsal lymph-sac died in 2–4 days. With regard to these last animals, the author notes that he had found the bacilli in their white corpuscles, but never, even in the splenic blood, in the warm-blooded animals.

Variations of Vibrio Proteus.†—Dr. G. Firtsch gives an account of some variations of *Vibrio Proteus* (Finkler-Prior's comma bacillus) which appeared in a cultivation that was certainly pure originally. The first variation was remarked in a plate cultivation 307 days old, and the new vibrio was distinguished from the true *V. Proteus* by the colonies having a more wavy contour, being of a yellowish colour, and being beset with small prominences. In two or three days' time the new vibrios were found to be massed together in the centre of the colonies. These differences were seen not only in 10 per cent. meat-pepton-gelatin, but in other media, in tube cultivations; and on microscopical examination, other distinctions could also be observed, but these were not so marked. The behaviour of this vibrio on nutrient gelatin may therefore be regarded as being the chief criterion of this variation, which was also found, together with the real *Vibrio Proteus*, in two cultivations a year old.

Two other variations were obtained from the original cultivations at still later periods. They are called vibrios 2 and 3, and show some slight differences from each other and from the original, the most notice-

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 193–207 (1 pl.).
† Arch. f. Hygiene, viii. (1888) p. 369.

able of these being that vibrio 3 varies from 5–150 μ long and from 0·8–1 μ thick.

The inference drawn by the author is that every kind of bacterium shows, for the same conditions and for the same media, the same forms; but for different external conditions and for different media many kinds of bacteria alter their course of development and change their shape and appearance. Hence it is incorrect to say that only one of these forms is the true or normal condition, and that all others are pathological.

Flagella of the Cholera Bacilli.*—It is a legitimate inference, says Dr. R. Neuhauss, from the fact of their lively movements, that cholera bacilli are possessed of flagella. After failing in various ways to demonstrate this appendage, the author hit upon the following method, which gave positive results. Cultivations were obtained in meat broth of bacilli, which in four weeks showed, instead of the tiny comma bacilli, long spirilla and large thick bacilli. Most of these had lost their motility, but a few specimens were still capable of movement. Cover-glass preparations, stained black by means of Campeachy wood extract and neutral chromate of soda, as well as unstained cover-glass preparations, failed to show the flagellum; nor by means of the Microscope could any such appendage be observed when the bacilli were mounted unstained in water, and pressed between the slide and cover-slip; but by photographing a preparation put up in this last-mentioned way, a negative was produced which showed a delicate spiral flagellum attached to a short much curved bacillus. By repeatedly taking the same field, and focusing for different levels, another flagellated bacillus was photographed. This result the author considers a great photographic triumph. Subsequent examination showed that the cultivation employed had remained quite pure.

Glischrobacterium.†—Dr. P. Malerba and Dr. G. Sanna-Salaris have isolated from the urine of a female, aged fifty, a bacterium which they believe to be the cause of a viscid stringy condition of this fluid. They also mention another case of glischruria, from which the same organism has been isolated. Besides the viscidity, this urine is remarkable for a considerable acidity, which lasts for 40–50 days at ordinary temperatures. It contains a few oxalates, is precipitated by tannic acid, and then loses its viscosity.

The micro-organism to which this viscid condition is ascribed is a coccus (long. diam. 1·14–0·57 μ; trans. diam. 0·41 μ). During its cultivation certain morphological differences were observed, and these were found to be due to differences of media, age, and temperature. Thus, in fresh non-peptonized bouillon the microbe is a bacillus endowed with a slight rotary movement; it may or may not be constricted in the middle, and may be arranged in pairs, or in chains. In old cultures the chains are superseded by a mass of bacteria, and long chains are rarely seen, except between 21° and 27°.

It stains well with fuchsin and methylen-blue.

Glischrobacterium grows on a large number of nutritive media: the colonies are spherical, with depressed centres and somewhat crenated margins. Occasionally they present an appearance like concentric rings traversed by lines radiating from centre to periphery. If the colonies

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 81–4.

† Arch. Ital. Biol., x. (1888) pp. 358–71 (1 pl.).

grow deep, they are usually ellipsoidal. In the course of a few days the deep colonies are surrounded by bubbles of gas (hydrogen).

Glischrobacterium does not liquefy gelatin, and, although it grows best in the presence of oxygen, is capable of anaerobic development. It grows well on agar, bouillon, milk, potato, serum, and egg-yolk, as well as on gelatin. In human saliva, either fresh, mixed, or sterilized, it thrives wonderfully. Human urine inoculated with some of the original urine, or with a pure cultivation, becomes viscid and stringy in 8–10 hours at 37° C., but experiments with dogs' urine sometimes failed.

The morphological characters of this bacterium are not affected by the chemical reaction of the nutrient media or by light, but are considerably affected by temperature. Thus, it grows best at 37° C., but not above 41°, or below 5° C. It is extremely sensitive to desiccation.

In experiments on animals the authors found that this bacterium, when injected into the pleural or peritoneal sacs (guinea-pigs, rabbits) is not harmful; that it does not multiply in the stomach or bladder (dogs); that under the skin (guinea-pigs, rabbits, and dogs) it is eminently pyogenic; that injected directly into the blood (dogs) it produces slight albuminuria, with structural alteration of the kidney, and after two or three days causes the urine to become stringy; and that, as a rule, the *Glischrobacterium* dies between the second and fourth days in the blood and in the organs, except in the kidney of the dog, where it lives for a time as yet undetermined.

Mucous Disease of Hyacinths.*—Dr. A. Heinz has found that hyacinths are affected by a wasting disease, attended with the production of a foul-smelling mucus. The flowering parts are specially attacked, but no part is exempt. Microscopical examination showed that the mucus and the tissues were full of a bacterium, which is a mobile rod, invariably single, with rounded ends, 4–6 μ long and about 1 μ thick. They propagate by direct fission, and stain well with all the usual dyes.

The bacillus was easily cultivated pure on gelatin, agar, and potato, and healthy plants inoculated from these cultivations showed evidences of disease, most marked about the inoculation spot, in twenty-four hours. Hence the author concludes that this microbe is the actual cause of the disorder, and the name given to it is *Bacillus Hyacinthi septicus.* It does not liquefy gelatin. Superficial colonies on plates are circular, about 2 mm. in diameter, bluish-white in colour, with a somewhat darker centre. Those lying deeper are oval, and of a dull yellowish-white. The cultivation differences on gelatin and agar are not noteworthy. On potato there forms in thirty-six hours a yellow slimy layer, and in a few days the cultivations give off a strongly offensive smell.

Other authors, notably Sorauer and Wakker, have described wasting diseases of hyacinths, attended with the production of mucus. These also were caused by bacteria, but Dr. Heinz considers that the disease observed by him is distinct from the yellow and white mucous degeneration of Wakker and Sorauer.

Bacteriology of Snow.†—Dr. F. G. Ianovsky, who has examined a February snow, collected immediately and from one to three days after its fall, finds:—(1) That even when collected during its fall, snow is invariably found to contain living bacteria in considerable numbers,

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 535–9.
† Vratch, 1888, p. 727. Cf. The Microscope, ix. (1889) pp. 115–7.

varying from 34–463 per cubic centimeter of snow-water. (2) That their number does not decrease from exposure of snow to low temperatures (– 16° C.) for several days. (3) That the three following species of microbes are constantly met with in great numbers:—(*a*) a large diplococcus composed of ovoid cocci, endowed with energetic motion, and characterized by its rapidly liquefying gelatin. In test-tube cultures greenish colonies form on the third day along the needle track, and assume the shape of a funnel-like sac, with a whitish flocculent deposit; while by the fifth the whole medium becomes liquefied, and the precipitate sinks to the bottom. On agar, a pale greyish streak is formed at the site of inoculation; on potato, a fairly thick white film. (*b*) Small-sized cocci, often arranged two and two, energetically mobile, and slowly growing on gelatin without liquefying the medium, the growth proceeding slowly along the track of the needle in the shape of a narrow strip consisting of non-coalescing points of a yellow colour, while on the surface the colony is seen as a greyish-white circular slightly prominent patch, with somewhat fringed edges. On agar the coccus forms a white streak with sinuous edges; on potato a grey film with a brownish tint. (*c*) Very large cocci, liquefying gelatin as late as three weeks after inoculation, and growing along the needle track in the form of a sharply defined streak of a pink colour, with a slightly elevated pink circular patch or cap on the surface. On agar the microbe forms a freely spreading white film with a rosy tint; on potato a thick tallow-like pink coat, with sharply defined fringed contours. (4) That the first two species are also met with commonly in the water of the river Dnieper, while the pink coccus seems to occur only in snow. (5) That, generally speaking, the microbes which liquefy gelatin are met with in greater variety and in far greater numbers in falling or recently fallen snow than in snow which has been on the ground for some time. This, in fact, very often contains such bacteria as do not liquefy gelatin. (6) That the bacteria of snow originate partly in aqueous vapours which are transformed into snow, partly and chiefly in the air—that is, they are carried away by the snow-flakes in their passage through the atmosphere.

MICROSCOPY.

a. Instruments, Accessories, &c.*

(6) Miscellaneous.

"The Compound Microscope invented by Galileo." † — A very interesting paper has been published by Prof. G. Govi, Hon. F.R.M.S., the eminent Italian physicist, in which he claims that Galileo was the inventor of the Compound Microscope.

It should be borne in mind at the outset in considering Prof. Govi's paper that, as stated by him in a letter to the French Academy of Sciences,‡ he understands by "simple Microscope" an instrument "consisting of a single lens or mirror," and by "compound Microscope" one "consisting of several lenses or a suitable combination of lenses and mirrors."

The following is a translation of Prof. Govi's paper:—

In a pamphlet published in 1881,(1) treating of the invention of the binocular telescope (attributed to D. Chorez, a French spectacle-maker), I thought it right to recall that Chorez himself, in 1625, used the Dutch telescope (with the convex objective and the concave ocular) as a Microscope, (2) and stated that with a similar Microscope—

"Un ciron apparoist aussi gros qu'un poids. Tellement qu'on discerne sa teste et ses pieds, et son poil, chose qui sembloit fabuleuse a plusieurs, iusqu'à ce qu'ils l'ont veuë avec admiration." ("A mite appeared as large as a pea; so that one can distinguish its head, its feet, and its hair—a thing which seemed incredible to many, until they witnessed it with admiration.")

To this quotation I added—

"This transformation of the telescope into a Microscope (or as opticians in our own day would say, into a Brücke lens) was not an invention of the French optician. Galileo had accomplished it in the year 1610, and had announced it to the learned by one of his pupils, John Wodderborn, a Scotchman, in a work which the latter had just published against the mad '*Peregrinazione*' of Horky. (3) Here are the exact words of Wodderborn (page 7):—

'Ego nunc admirabilis huius perspicilli perfectiones explanare nō conabor: sensus ipse iudex est integerrimus circa obiectum proprium. Quid quod eminus mille passus et ultra cum neque viuere iudicares obiectum, adhibito perspicillo, statim certo cognoscas, esse hunc Socratem Sophronici filium venientem, sed tempus nos docebit et quotidianæ nouarum rerum detectiones qua egregie perspicillum suo fungatur munere, nam in hoc tota omnis instrumenti sita est pulchritudo.

'Audiueram, paucis ante diebus authorem ipsum Excellentissimo

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

† 'Il microscopio composto inventato da Galileo. Memoria di Gilberto Govi.' 33 pp., 4to, Napoli, 1888. (Extract from vol. ii. series 2 of Atti R. Accad. Sci. Fis. Nat. Napoli. Cf. also Comptes Rendus, cvii. (1888) pp. 551-2; Scientific News, ii. (1888) pp. 431-2; and this Journal, 1888, pp. 1067-8, and *ante*, p. 163.—The numbers in brackets refer to the notes collected in the Appendix.

‡ Comptes Rendus, cvii. (1888) pp. 551-2.

D. Cremonino purpurato philosopho varia narrante scitu dignissima et inter cætera quomodo ille minimorum animantium organa motus, et sensus ex perspicillo ad vnguem distinguat; in particulari autem de quodam insecto quod utrumque habet oculum membrana crassiuscula vestitum, quæ tamen septē foraminibus ad instar larvæ ferreæ militis cataphracti terebrata, viam præbet speciebus visibilium. En tibi (so says Wodderborn to Horky) nouum argumentum, quod perspicillum per concentrationem radiorum multiplicet obiectū; sed audi prius quid tibi dicturus sum: in cæteris animalibus eiusdem magnitudinis, vel minoris, quorum etiam aliqua splendidiores habent oculos, gemini tantum apparent cum suis superciliis aliisque partibus annexis.'

"I have wished to quote this passage of Wodderborn textually, so that the honour of having been the first to obtain from the Dutch telescope a *compound* Microscope should remain with Galileo, which he later called '*Occhialino*,' and that the glory of having reduced the *Kepplerian* telescope to a Microscope (in 1621) should rest with Drebbel. The apologists of the Tuscan philosopher, by attributing to him the invention of the Microscope without specifying with what Microscope they were dealing, defrauded Drebbel of a merit which really belongs to him, but the defenders of Drebbel would act unjustly in depriving Galileo of a discovery which incontestably was his."

I turn now to Wodderborn's account, published in 1610 (the date of the dedication to Henry Wotton, English Ambassador at Venice, is October 16th, 1610), which reads thus:—

"I will not now attempt to explain all the perfections of this wonderful *occhiale*, our sense alone is a safe judge of the things which concern it. But what more can I say of it, than that by pointing a glass to an object more than a thousand paces off, which does not even seem alive, you immediately recognize it to be Socrates, son of Sophronicus, who is approaching! But time and the daily discoveries of new things will teach us how admirably the glass does its work, for in that alone lies all the beauty of that instrument.

"I heard a few days back the author himself (Galileo) narrate to the Most Excellent Signor Cremonius various things most desirable to be known, and amongst others, in what manner he perfectly distinguishes with his telescope the organs of motion and of the senses in the smaller animals; and especially in a certain insect which has each eye covered by a rather thick membrane, which, however, perforated with seven holes, like the visor of a warrior, allows it sight. Here hast thou a new proof that the glass concentrating its rays enlarges the object; but mind what I am about to tell thee, viz. in the other animals of the same size and even smaller, some of which have nevertheless brighter eyes, these appear only double with their eyebrows and the other adjacent parts."

These last words of Wodderborn's were directed to confute the accusation of those who attributed to a fault in the telescope all that was unknown to them before, and that was being discovered by the use of it; being unwilling to admit the mountainous surface of the moon, the satellites of Jupiter, and the new stars of the Milky Way, or any other new discovery made by Galileo; because, said these people, the ancients, and especially Aristotle, make no mention of them. (4)

After reading this document it is impossible to refuse Galileo the credit of the invention of a *compound Microscope* in 1610, and the application of it to examine some very minute animals; and if he himself neither then nor for many years after made any mention of it publicly, this cannot take away from him or diminish the merit of the invention.

It is not to be believed however, that Galileo after these first experiments quite forgot the Microscope, for in preparing the *Saggiatore* between the end of 1619 (5) and the middle of October 1622 (6) he spoke thus to Lotario Sarsi Segensano (anagram of Oratio Grassi Salonense) (7) :—

"I might tell Sarsi something new if anything new could be told him. Let him take any substance whatever, be it stone, or wood, or metal, and holding it in the sun, examine it attentively, and he will see all the colours distributed in the most minute particles, and if he will make use of a telescope arranged so that one can see very near objects, he will see far more distinctly what I say."

It will not therefore be surprising if in 1624 (according to some letters from Rome, written by Girolamo Aleandro to the famous M. de Peiresc (8)) two Microscopes of Kuffler, or rather Drebbel, having been sent to the Cardinal of S. Susanna, (9) who at first did not how to use them, they were shown to Galileo, who was then in Rome, and he as soon as he saw them explained their use, as Aleandro writes to Peiresc on the 24th May, adding, "Galileo told me that he had invented an Occhiale which magnifies things as much as fifty thousand times, so that one sees a fly as large as a hen."

This assertion of Galileo that he had invented a telescope which magnified 50,000 times, so that a fly appears as big as a hen, must without doubt be referred to the year 1610, and from the measure given of the amplification by the solidity or volume the linear amplification (as it is usually expressed now) would have been equal to something less than the cubic root of 50,000, that is, about 36, and that is pretty fairly the relative size of a fly and a hen.

Aleandro's letter of May 24th (1624) does not state at what time Galileo saw the telescope and explained the use of it, but another letter of Faber's to Cesi, amongst the autograph letters in the possession of D. B. Boncompagni, (10) says (11th May) :—

"I was yesterday evening at the house of our Signor Galileo, who lives near the Madalena; he gave the Cardinal di Zoller a magnificent eyeglass (11) for the Duke of Bavaria. I saw a fly which Signor Galileo himself showed me; I was astounded, and told Signor Galileo that he was another creator, in that he shows things that until now we did not know had been created."

So that even on the 10th May, 1624, Galileo had not only seen the telescope of Drebbel and explained the use of it, but had made one himself and sent it to the Duke of Bavaria.

We lack documents to show how this Microscope of Galileo was made, that is, whether it had two convergent lenses like those of Drebbel. A letter of Peiresc of the 3rd March, 1624, says that "the effect of the glass is to show the object upside down . . . and so that the real natural motion of the animalcule, which, for example, goes from east to west, seems to go contrariwise, that is, from west to east"), or whether it was not rather composed of a convex and a concave lens, like that made earlier by him, and used in 1610, and then almost forgotten for fourteen years.

It is, however, very probable that this last was the one in question, for Peiresc, answering Aleandro on the 1st July, 1624, wrote:—

"But the occhiale mentioned by Signor Galileo, which makes flies like hens, is of his own invention, of which he made also a copy for Archduke Albert of pious memory, which used to be placed on the ground, where a fly would be seen the size of a hen, and the instrument was of no greater height than an ordinary dining-room table."

Which description answers far better to a Dutch telescope used as a Microscope in the same way exactly as Galileo had used it, rather than to a Microscope with two convex lenses. (12)

One cannot find any further particulars concerning Galileo's "*occhialini*" (so he had christened them in the year 1624), either in Bartholomew Imperiali's letter of September 5th, 1624, in which he thanks Galileo for having given him one in *every way perfect*, or in that of Galileo to Cesi of September 23rd, 1624, accompanying the gift of an "*occhialino*," or in Federico Cesi's answer of October 26th, or in a letter of Bartholomeo Balbi to Galileo of October 25th, 1624, which speaks of the longing with which Balbi is awaiting "the little *occhiale* of the new invention," or in that of Galileo to Cesar Marsili of December 17th in the same year, in which Galileo says to the learned Bolognese, "that he would have sent him an *occhialino* to see close the smallest things, but the instrument-maker, who is making the tube, has not yet finished it." (13) This, however, is how Galileo speaks of it in his letter to Federico Cesi written from Florence on September 23rd, 1624, more than three months after his departure from Rome:—

"I send your Excellency an *occhialino*, by which to see close the smallest things, which I hope may give you no small pleasure and entertainment, as it does to me. I have been long in sending it, because I could not perfect it before, having experienced some difficulty in finding the way of cutting the glasses perfectly. The object must be placed on the movable circle which is at the base, and moved to see it all; for that which one sees at one look is but a small part. And because the distance between the lens and the object must be most exact, in looking at objects which have relief one must be able to move the glass nearer or further, according as one is looking at this or that part; therefore the little tube is made movable on its stand or guide, as we may wish to call it. It must also be used in very bright clear weather, or even in the sun itself, remembering that the object must be sufficiently illuminated. I have contemplated very many animals with infinite admiration, amongst which the flea is most horrible, the gnat and the moth are most beautiful; and it was with great satisfaction that I have seen how flies and other little animals manage to walk sticking to the glass and even feet upwards. But your Excellency will have the opportunity of observing thousands and thousands of other details of the most curious kind, of which I beg you to give me account. In fact, one may contemplate endlessly the greatness of nature, and how subtilely she works, and with what unspeakable diligence.—P.S. The little tube is in two pieces, and you may lengthen it or shorten it at pleasure."

It would be very strange, knowing Galileo's character, that, in 1624, and after the attacks made on him for having perhaps a little too much allowed the Dutch telescope to be considered his invention, he should have been induced to imitate Drebbel's glass with the two convex lenses, and have wished to make them pass as his own invention, whilst he had always used and continued to use to the end of his days, telescopes with a convex and a concave lens without showing that he had read or in the least appreciated the proposal made by Keppler, ever since 1611, to use two convex glasses in order to have telescopes with a large field and more powerful and convenient.

In any case it is impossible to form a decided opinion on such a matter, the data failing, but the very fact, that from 1624 onwards, Galileo thought no more of the *occhialino* (probably because he found it less powerful and less useful than the *occhiale* of Drebbel), as he had not occupied himself with it or had scarcely remembered it from the year 1610 to 1624, seems sufficient to show that the *occhialino*, like the Microscope of 1610, was a small Dutch telescope with two lenses, one convex and one concave, and not a reduced Kepplerian telescope like that invented by Drebbel in 1621.

The name of Microscope, like that of telescope, originated with the Academy of the Lincei, and it was Giovanni Faber who invented it, as shown by a letter of his to Cesi, written April 13th, 1625, and which is amongst the Lincei letters in the possession of D. B. Boncompagni. Here is the passage in Faber's letter :—

"I only wish to say this more to your Excellency, that is, that you will glance only at what I have written concerning the new inventions of Sig. Galileo ; if I have not put in everything, or if anything ought to be left unsaid, do as best you think. As I also mention his new *occhiale* to look at small things and call it Microscope, let your Excellency see if you would like to add that, as the Lyceum gave to the first the name of telescope, so they have wished to give a convenient name to this also, and rightly so because they are the first in Rome who had one. As soon as Sig. Rikio's epigram is finished, it may be printed the next day; in the meanwhile I will get on with the rest. I humbly reverence your Excellency.—From Rome, April 13th, 1625. Your Excellency's most humble servant, GIOVANNI FABER (Lynceo)."

Faber himself, in the 'Rerum Medicarum Novæ Hispaniæ Thesaurus,' of Hernandez, (14) which was being printed at the expense and by the care of the Lyceum, and came out in a few imperfect copies in 1630, reappearing in 1649, and definitely in 1651, speaking of the *occhiale* by which to see minute objects (p. 473), wrote thus :—

"Vidimus et ad miraculum usque obstupuimus ante paucolos dies (15) domi meæ per Tubum opticum miræ perspicuitatis artificiosissime elaboratum à duobus Germanis huius artificibus fabrisq. nobis allatum donatumque; quem a Telescopij imitatione et rerum minutarum conspectu *Microscopium* nominare libuit."

And a little further on (p. 474), after having spoken of the *Cannocchiale*, which had received the name of Telescope from the President of the Lyceum, Frederic Cesi, he continues :—

"Ab hoc nobis alterum Microscopium appellare visum fuit . . . quod quidem a Galileo etiam anno proxime elapso in urbem allatum, nunquam tamen ita diligenter elaborari ab ullis artificum manibus vel ipsius vel collegarum jussu potuit quam ab istis Germanis, qui sedulam in hoc operam præstitere, nec pauca huiusmodi Microscopia quæ urbem totam in admirationem pertraxerunt, elaborata nobis exhibuerunt."

The preceding quotation was a part of that 'Scritto delle noue invenzioni del Sig. Galileo' which Faber was sending to Cesi, that he might look it through with his letter of April 13th, 1625, above quoted.

This 'Scritto' is now in the possession of the Accademia dei Lincei, in a large manuscript volume entitled, '318 Varia principis Cæsii Lynceorum Academiæ, 985,' where it is found on p. 372 recto, and was printed by Faber, with slight variations, in the book already quoted of 'Tessoro Messicano.'

The Abbé Rezzi, in a work of his on the invention of the Microscope, (16) thought that he might conclude from the passage of Wodderborn, reproduced above, that Galileo did not invent the compound Microscope, but gave a convenient form to the simple Microscope, and in this way as good as invented it, for the Latin word used by Wodderborn, perspicillum, "signified at that time, it is clear (Rezzi says), no other optical instrument than spectacles or the telescope, never the Microscope, of which there is no mention whatever in any book published at that time, nor in any manuscript known till then."

But Rezzi was not mindful that on the 16th October, 1610, the date of Wodderborn's essay, the name of Microscope had not yet been invented, nor that of telescope, which, according to Faber, was the idea of Cesi, according to others of Giovanni Demisiano of Cephalonia, at the end (perhaps) of 1610, but more probably at the time of Galileo's journey to Rome from the 29th March to the 4th June, 1611. If, therefore, the word Microscope had not yet been invented, and if the telescope or the *occhiale*, as it was then called, was by all named *perspicillum*, one cannot see why Wodderborn's *perspicillum* cannot have been a *cannocchiale* (telescope) smaller than the usual ones, so that it could easily be used to look at near objects, but yet a *cannocchiale* with two lenses, one convex and one concave like the others, and, therefore, a real *compound Microscope*, although not mentioned by that name either by Wodderborn or others. And besides that, how could it be that Wodderborn beginning to treat "Admirabilis hujus perspicilli," that is, of the *telescope* in the first line, should then have called *perspicillum* a single lens in the eleventh line of the same page? Rezzi's mistake is easily explained, remembering that he had not under his eyes Wodderborn's essay, but only knew a brief extract reported by Venturi. (17)

Less excusable is Rezzi's remark, that Galileo had been led to make a Microscope of the one objective lens (perspicillum) of his telescope, by a letter of Magini of the 28th September, 1610, (18) in which the astronomer of Bologna tells him that, "Elongating the tube to double the distance from its point of sight, and taking away the *traguardo* or concave lens, one sees everything upside down, and very distinct although very small."

The cannocchiale, or rather the objective of the cannocchiale, used in such a way to observe with the naked eye the reversed real image of the object, would have been a singular discovery for better examining small objects, as instead of showing them *larger* they would have looked *smaller* than when observed by the naked eye. But Magini was not aware that only the images of those objects looked smaller which were placed in front of the objective lens at a distance greater than double its principal focus, whilst the images of objects situated between that distance and the focus of the lens were enlarged relatively to the object from which they originate, although always reversed. But even if he had known this peculiarity, it could not have suggested the idea of a simple Microscope, for with this one does not look at a real image, but at a virtual image of the object; not at a reversed image, but at one erect; not at an image now less and now greater than the object, but an image always larger than the object from which it arises.

Magini's observation could not therefore suggest to Galileo the idea of a simple Microscope, for it was the very opposite of it, and further because the simple Microscope was at that time (as will be shown) an invention more than three centuries old. We see from this that the good Abbé Rezzi must have been a most learned man, a man of letters, but totally ignorant of the elements of optics, for we cannot suppose him animated by the desire to deprive Galileo of the honour of having invented the compound Microscope.

As, however, amongst those not versed or badly versed in the subjects and language of science, many may in good faith repeat the words and arguments of Rezzi, thinking them correct, it is necessary to fully understand the meaning of the expressions *simple Microscope* and *compound Microscope*, so that in the future the like errors should not be renewed. . . .*

A single lens used to see, enlarged, the images of objects is called a simple Microscope, but the same name is sometimes given, though wrongly, to the ensemble of several lenses placed one over the other provided they are close together or the intervals separating them are very small relatively to the focus of each lens, because then the different lenses act as if they were a single one of shorter focus than each individual one.

We call a compound Microscope one to form which several lenses are used separated by considerable intervals, whether these lenses are of the same or of different kinds, the lens on the side of the object being called the objective, and the one next the eye the ocular. . . .†

Having in such a way determined what is meant by *simple Microscope* and *compound Microscope*, we must first of all find out to whom we owe the invention of the simple Microscope.

Although it results from a passage of Seneca (20) that the ancients had noticed the apparent enlargement of objects seen through a spherical glass vase full of water, yet the fact of there being no mention of *lenses* in the Optics of Euclid, nor in those of Heliodorus of Larissa, nor in Damian, nor in what remains of the Optics of Ptolemy, and what is more, the reasons adduced with great erudition by Thomas Henri Martin in his dissertation (21) sufficiently prove that the ancients had no lenses properly so called, and that therefore they did not know either simple or compound Microscopes.

In spite of this it will not be inopportune to mention briefly here the pretended concave emerald lens, which several writers, even very recent ones, quoting Pliny, have supposed to have been used by Nero to watch the fights of the gladiators.

The celebrated naturalist of Como, speaking 'De diversitate oculorum,' lib. xi. 53 et seq., says first of all that "alii contuentur longinqua, alii nisi prope admota non cernunt;" then he adds a little further that Nero's eyes were (ib., 54) "nisi quum conniveret, ad prope admota, hebetes," that is, that Nero's eyes were only able to see near objects when he half closed them, or, in other words, Nero was a myope, for half shutting the eyes or bringing the eyelids together is of no use to long-sighted people to see objects near them, or even to look

* A few paragraphs which deal with elementary points are omitted here.
† Ibid.

at objects at a distance. This interpretation of the passage of Pliny is confirmed by the words of the preceding paragraph (ib., 53): "oculi . . . in homine . . . prominentes, quos hebetiores putant, etc.;" but prominent eyes are almost always short-sighted eyes, and therefore the epithet *hebetiores* corresponded to *short-sighted* ones; and Nero's eyes having been called *hebetes* in the passage quoted just before, will have been short-sighted, which is also asserted by Suetonius, (22) who says ("oculis cæsiis et hebetioribus"), with sea-green or pale-blue eyes, and very weak, that is, only good for seeing very near objects, or in other words, with the eyes of a myope.

And that the epithet *hebes* (blunt, obtuse, inefficient, weak, &c.) applied to the eye did with the ancients correspond to our word *myope* we have another proof in this, that up to the beginning of the seventeenth century they continued to call weak sights, and spectacles for weak sights, the eyes and spectacles of the short-sighted. (23)

That other passage of Pliny also clearly makes allusion to Nero's short sight (lxxxvii. 16), which has made many believe that the ancients were acquainted with concave lenses, and used them to lengthen the sight of short-sighted people. This passage of the celebrated naturalist says that these emeralds "quorum . . . corpus extensum est (eadem, qua specula, ratione), supini imagines rerum reddunt. Nero princeps gladiatorum pugnas spectabat smaragdo." "These emeralds, which are sufficiently large (acting like looking-glasses) placed with the reflecting face upwards, give the images of things. The Emperor Nero watched the fights of the gladiators with an emerald."

Now, speaking in this passage exclusively of emeralds large enough to be used as mirrors, one cannot understand how with some learned men these mirrors in passing through Nero's hands can have become lenses. Pliny speaking therefore in this place not of a lens but of an emerald mirror, every one will easily understand that a mirror would have been useless to Nero, if he were long-sighted; for neither a plane nor a convex nor a concave mirror would have been of any use to a long-sighted person to look at things a long way off, for a long-sighted man sees far without any aid whatever.

On the other hand, if Nero was short-sighted, an emerald with its top surface worked spherically with its face uppermost, as Pliny says in front of and below the two eyes, or it might be below the one, could have perfectly fulfilled the office of a concave lens, and present the short-sighted emperor at a few centimetres from his eyes the images of the amphitheatre, and of its distant gladiators, and enable him thus to see them distinctly. The same effect might have been produced by an emerald, plane on the side turned towards the eyes and the objects to be viewed, and spherically concave beneath, as according to Pliny many were then made (xxxvii. 16): "Iidem (emeralds) plerumque et concavi ut visum colligant." "One often finds some (emeralds) concave to collect sight," that is, it shows many things in a small field, for in that case the reflection takes place on the convex surface of the scooped-out face, and the light in passing from the emerald to the air must have been strong, and given rise to virtual images very clear and close to the eyes of the observer. (24)

One must not think emeralds large enough to serve as looking-glasses with convex surfaces especially rare, as there are emeralds ten centimetres long and five wide, others five long and three wide, (25) not to mention emeralds (?) four cubits long and three wide, and others larger still mentioned, although doubtfully, by Pliny and Theophrastus.

We must, however, note that the ancients confounded many different stones under the name of emeralds, and who knows how often they may have also given the name of emeralds to glass tinted a beautiful green, as the sacred basin in green glass in the possession of the Genoese was believed to be and is still reputed by many an emerald. The Genoese obtained it in 1102 from Cesarea, where it passed for the cup of Christ's Last Supper.

The ancients therefore had no lenses either convex or concave, or at least no document is extant to show that they had any or knew how to use them.

With the decadence of the Roman power the arts and sciences fell also, and when the seat of the Empire passed from Rome to Constantinople, night fell on the intellectual world, and the nations tossed in a long and fearful sleep, during which only torments and prodigies were invented.

The beginning of the middle ages was really the age of darkness, but after the year 1000 minds having reopened to hope and intellects to study, there began to dawn some light of science, so that in 1276 a Franciscan monk, Roger Bacon, of Ilchester, in his 'Opus Majus,' dedicated and presented by him to Clement IV., (26) could show many marvellous things, and amongst these the efficacy of *crystal* lenses, in order to show things larger, and in this wise he says make of them "an instrument useful to old men and those whose sight is weakened, who in such a way will be able to see the letters sufficiently enlarged, however small they are." As long as no documents anterior to him are discovered, Roger Bacon may be considered the first inventor of convergent lenses, and therefore of the *simple Microscope*, however small the enlargement by his lenses may have been.

As, however, that man of rare genius, the initiator of experimental physics, had brought on himself the hatred of his contemporaries, they kept him for many years in prison, then shut him up in a convent of his order to the end of his long life, of nearly eighty years. His writings had to be hidden, at least those treating on natural science, to save them from destruction, and so the invention of lenses, or the knowledge of their use to enlarge images and to alleviate the infirmities of sight, remained unknown or forgotten in the pages of the famous 'Opus Majus' which only came to light in 1733, by the care of Samuel Jebb, a learned English doctor.

A Florentine, by name Salvino degli Armati, at the end of the thirteenth century (1280 ?) (in Bacon's life-time), had therefore the glory of inventing spectacles, and it was a monk of Pisa, Alexander Spina, who suddenly charitably divulged the secret of their construction and use.

Perhaps Salvino degli Armati and Spina really discovered more than Roger Bacon had discovered; that is, they found out the use of converging lenses for long-sighted people, and of diverging lenses for short-sight, whilst the English monk had only spoken of the lenses for long sight, and perhaps they added to this first invention the capability of varying the focal lengths of the lenses according to need, and the other of fixing them on to the visor of a cap to keep them firm in front of the eyes, or to fasten them into two circles made of metal, or of bone joined by a small elastic bridge over the nose. However it may be, the discovery of spectacles, or as it may be called, of the *simple Microscope*, may be equally divided between Roger Bacon and Salvino degli Armati, leaving especially to the latter the invention of spectacles.

The first lenses for spectacles were it seems made from rock crystal and beryl, and either because they believed those made of glass hurtful to the sight, or void of any virtue, or in order to prevent the fraud of giving glass for crystal, Venice, in April 1300, (27) strictly prohibited glaziers selling, as if made of crystal, the *rotelle da occhi* (roidı da ogli), round shields for the eyes, and *le pietre da leggere* (lapides ad legendum), reading-stones.

But a year later, 15th June, 1301, the old Giustizieri who superintended the arts, allowed every one to make *Vitreos ab oculis ad legendum*, on condition that they should be sold as glass and not as crystal; and in March 1317, they granted the privilege of making *oglarios de vitro*, and to sell them in Venice in spite of the chapter of the guild of crystal-makers.

The first lenses having been cut in beryl or in rock crystal, led them to be indifferently called *Berilli*, as in those days very different gems were confused under the same name, and in Germany the word *Brillen* has remained for all lenses, whilst the French for the same reason first called spectacles *Bericles*, and then *Bésicles* (by corruption), which the Piedmontese in their dialect used to call and still call *Buricole*. Nicolò Krebs, from Cuss, better known under the name of Nicolò Cusano, who lived from 1401 to 1464, called one of his writings *Berillo*, because, thanks to its help, things otherwise incomprehensible could be understood, and in the second chapter of this book he says (28):—

"The beryl is a resplendent, colourless, and transparent stone, to which is given a concave or convex form, and those who look through it succeed in discovering things at first invisible."

De la Borde (29) quotes a passage of a certain writing of the sixteenth century, in which the cost is mentioned: "Pour dix paires de lunettes apportées à deux fois audit Seigneur Roy audit lieu de Bar, dont y en avoit trois paires de cristal et les autres de béril." ("For ten pairs of spectacles brought at two different times to the said Lord the King, at the said place of Bar, of which three were crystal and the others beryl.")

This shows that in those days they continued making lenses of crystal and beryl for those gentlemen who could afford them. Little by little, however, the use of beryl lenses disappeared, and even rock-crystal ones have become rarer, although they are still made especially to prevent their being scratched or dulled too soon by use.

But if from the time of Roger Bacon it was known that convex lenses enlarged the images of objects, (30) so that one could obtain enlargements of objects from five to ten times, and therefore one could with them see small objects sufficiently enlarged, yet no advantage for the knowledge and study of nature could be derived from them. One possessed the simple Microscope, but the observers and the observations were wanting.

Girolamo Fracastoro, in his book on 'Omocentrici,' published in 1538 (chapter vii.), says that, "Per duo specilla ocularia si quis perspiciat, altero alteri superposito, maiora multo, et propinquiora videbit omnia." And a little further on, chapter xxiii., "Quinimo quædam specilla ocularia fiunt tantæ densitatis ut si per ea quis aut Lunam, aut aliud syderum spectet adeo propinqua illa judicet, ut ne turres ipsas excedant" —words which, misunderstood by some, made people believe that Fracastoro was aware of the telescope, whilst in this passage he only makes mention of simple lenses, and like one who did not know the theory of them and had studied insufficiently their effects, exaggerates their efficacy, imagining lenses powerful enough to enlarge the moon, as simple spectacles or as two spectacles placed one over the other enlarge the letters of a book.

Giambattista della Porta repeated later in his 'Magia Naturale' (31) the same things, and almost in the same words, so that many (and amongst others Kepler) attributed to him the invention of the Dutch telescope, which he himself (after having seen it once) imagined he had invented, although Stotiola his friend relates (32) that he died of fatigue in trying to discover the cause of it, which he could not fathom.

The man who under the name of Alimberto Mauri dictated some of the 'Considerazioni sopra alcuni luogi del Discorso di Lodovico delle Colombe intorno alla stella apparita nel 1604 ('Reflections on some passages of the Discourse of Lodovico delle Colombe about the star which appeared in 1604'), (33) speaks also in 1606 of the enlargement obtained with the lenses of spectacles, and therefore with the simple Microscope. Delle Colombe suspected this to have been suggested if not written by Galileo. (34)

"Although," says Mauri, "spectacles were discovered for the first time in 1280, (35) nevertheless their use having in this long lapse of time entirely fallen to base objects, has never been, until now by you, employed and adapted in favour of astrology and high and celestial things."

And here, in order to dissipate the suspicion that Delle Colombe had invented the telescope in 1605, one must know that Alimberto Mauri, by the words now quoted, wished to ridicule a strange thought of Delle Colombe, who to explain the appearance of the new star of 1604, attributed the function of a large lens to a part of the "crystalline heavens" interposed between our eyes and the "primum mobile," where the new star was situated.

"Because," says Ludovico delle Colombe, (36) "in the case of an object which is not seen on account of its distance, if we come near to it, or if the transparent medium through which we look magnifies it, we see it as distinctly as objects are seen clearly and as if they were near, by those persons who having short sight, by means of spectacles which represent visible objects magnified, discover those things which without the aid of such means they could not see. . . .

"It therefore appears that the new star and other similar stars which have appeared at divers times, and which may possibly be seen hereafter, are true and real stars created in the heavens from the beginning, but in the primum mobile, and rendered visible by some denser parts of the crystalline heavens situated beneath."

In the year 1612 they used without doubt lenses or simple Microscopes to see things enlarged, for Boccalini in his 'Ragguagli di Parnasso,' published that year, writes thus:—

"But most admirable are those occhiali, made with such art that they make fleas look like elephants, pigmies like giants. These are eagerly bought up by some great folks, who placing them on the nose of their unfortunate courtiers so alter the sight of the wretches that they esteem the low favour of being slapped on the shoulder by the master, or being looked at by him with a grin even artificial and forced, worth the remuneration of an income of five hundred crowns."

Which passage reproduced in the 2nd edition of the same Collection, published in 1614 (' Ragguaglio primo,' p. 4, line 4 and following), continues thus :—

" But the occhiali lately invented in Flanders are bought at a high price by these same personages and then made a present of to their courtiers, which when used by them make them see as very near them those prizes and those dignities which are not within reach of their sight, and which may never be within reach of their age."

From this addition of Boccalini's one sees that in the first passage the word *occhiali* is used for *lenses* and not telescopes as some believed, through reading only the first edition of the book, since the telescope is clearly indicated in the addition, it being called " occhiale lately invented in Flanders."

We may therefore conclude from what has been said that although lenses for the enlargement of objects had been discovered, their use was scarcely understood, and they were only used for *base objects* as Alimberto Mauri affirms, without any one thinking of using them to increase our knowledge of the smaller details of large objects, or the existence of very small objects undiscernible to the naked eye.

Many strange ideas were mooted in those times concerning lenses (and some have been seen in the preceding quotations), because all who had made use of them had confused the enlargement of the ocular image produced by the lens with the approach of the same image to the eye, although these two things are completely different.

When an object is examined through a convex lens, and the enlarged virtual image of the object is seen, instinct makes us believe it to be very near, although at times it is really at an infinite distance, and the eye adapts itself to look at it at that distance, as if it were looking without the aid of a lens at an object at a great distance. This sensation (or rather this invincible feeling of a sensation, invincible even for those who know quite well that converging lenses make us see the object far more distant from the eye than it really is) springs from our powerlessness to estimate distance at sight, especially in the case of rather long distances and of things looked at with only one eye, if the apparent size of the object does not help us to judge its distance better. Now on looking through a converging lens the objects almost all appear to us of the same size, whether their image is formed quite close to the eye or at an enormous distance. (37)

In this way, comparing through a lens a very large object with its more minute details, which we know to be small, and not being able to recognize the true place of its image, we believe it to be near, although it is always further off than the object from which it arises.

The contrary happens with diverging lenses, which, producing on the retina a smaller image than would be shown to the naked eye by the object observed if it were placed at the same distance at which its image is formed, we imagine the image to be very distant, whilst it really is always nearer the eye than the object seen.

This illusion concerning the real distance of images contemplated through a lens explains the expressions already quoted, from Roger Bacon, Fracastoro, del Porta, Lodovico delle Colombe, and Alimberto Mauri, who repeatedly mention images brought near and enlarged by the use of converging lenses, and they show their belief that with appropriate lenses one can bring nearer and then enlarge the images of most distant objects, and especially of the stars. These expressions only really reveal the lack of knowledge in those times of the manner in which vision is effected, and of the function of lenses in the formation of images.

From all that we have now set forth it appears sufficiently demonstrated that at the beginning of the seventeenth century they had already possessed for more than 300 years lenses capable of enlarging the images of objects, that this enlarging power of the lenses was known, but that no one until then had made any use of it as a simple Microscope to study things more minutely and to progress in the knowledge of nature. (38)

It was the discovery of the Dutch telescope, and still more the celestial discoveries made by Galileo, which drew the attention of the learned towards lenses and their properties, and the passage of Wodderborn, mentioned at the beginning of this paper, permits us to affirm that if the Florentine philosopher was not the inventor of the telescope (as he has himself candidly declared in many places), he was without doubt the inventor of the compound Microscope, having used from 1610 a Dutch telescope to look at near and minute objects, and having discovered with it various details unknown by him till then in some common animalcules, on which the learned men of those days did not deign to fix their eyes, intent as they were in seeking the origin, reason, and properties of things in Aristotle's Category and in the artifices of laboriously barren dialectics.

Contrary, therefore, to the conclusions of the Abbé Rezzi, we must affirm that Galileo did not invent the *simple Microscope*, because it had already been invented for centuries, but invented instead the *compound Microscope* with a convex and a concave lens, and was the first to make use of it to increase our knowledge of natural things.

To better secure for Galilco the invention of the compound Microscope one might have quoted also the words of Viviani in the life of his master published by Salvini in the 'Fasti Consolari,' (39) and those placed by the same Viviani on the front of his house in Florence in Via Sant' Antonino (formerly Via dell' Amore), No. 13. (40) But the enthusiastic admiration of Viviani for Galileo has made him many times fall into such exaggeration with regard to Galileo's discoveries, that it lessens the authority of his words, especially in the matter of optics, of which it does not appear from his writings that Viviani ever understood very much.

Neither, for the same reason, will we quote the 'Oratio de Mathematicæ laudibus habita in florentissima Pisarum Academia cum ibidem publicam illius scientiæ explicationem aggressus foret' (Romæ, Typo. Jacobi Mascardi, 1627, 4to) of Niccolò Aggiunti, disciple of Galileo, although it may be useful to recall the passage where Aggiunti, speaking of Galileo's Microscope, says, "dudum vero telescopioli usu ita sensum visus exercuimus, etc. etc.," for also from these words, pronounced in 1626, one finds that the *occhialino* of Galileo was a small telescope (*telescopiolum*, a word which for Aggiunti, as for others, then meant only the Dutch telescope), and therefore differed, as before stated, from Drebbel's Microscope.

On the other hand, no testimony in favour of Galileo's invention can be more explicit and more sure than Wodderborn's, corroborated by Galileo's own declaration in 1624, after he had seen Drebbel's Microscopes, as referred to by Aleandro.

As to the pretensions put forward by Pierre Borel in favour of Janssen, (41) or to the boasts of Francesco Fontana, (42) it will suffice to show how the first were only put forward in 1655, that is, half a century after the supposed invention, and the others in 1646, after Fontana had had notice of Drebbel's Microscopes in 1625, indeed had seen some in Fabio Colonna's house without at first understanding the meaning of them, as is shown by certain letters of Colonna, which were printed in the last century in the 'Giornale dei Letterati' of Rome. (43)

D. Chorez, Drebbel, and Fontana, who after 1610 made Microscopes with a convex and a concave lens, were not inventors, but reproducers of Galileo's compound Microscope. Others coming later, without usurping the invention of Galileo, spoke of it without giving it as his. So did Manzini in his 'Occhiale all' occhio' (1660), and I am convinced that in looking through the writers on optics after Manzini we should find several who since that time described Galileo's Microscope without attributing it to its real author. (44)

Also the ingenious French optician Charles Chevalier, in his 'Manuel du Micrographe,' published in 1839, brought forward again as a novelty the Galilean Microscope, being ignorant without doubt that the invention was over 200 years old.

Latterly the same thing happened to the celebrated German physiologist Ernest William Brücke, whose "working lens," which now all naturalists know under the name of the "Brücke lens," is really nothing but the ancient "occhialino" of Galileo, modernized in shape, with better lenses, and limited to lesser amplification.

At the meeting of the 8th May, 1851, Prof. Brücke (45) presented to the Academy of Sciences of Vienna a species of Microscope, termed by him working lens (Arbeitsloupe), intended to facilitate anatomical studies, because it has a large frontal distance, in spite of its amplifying power of six and more diameters. This working lens consisted of a brass cylinder 90 mm. long and 40 mm. in diameter, which had at one extremity a couple of achromatic lenses taken from an aplanatic ocular of a large compound Microscope of Plössl, and at the other extremity a biconcave lens taken from an opera-glass. The two converging glasses placed together acted as a single lens, but rendering the field of vision more uniform and clear. The objects to be observed were placed at 75 mm. from the objective, and appeared to be enlarged 5 times at 165 mm. distance from the eye, and about 6·6 times at 8 Parisian inches, or 216·56 mm. from the eye.

If the same enlargement at the same distance was wanted with a single lens, a lens of 41·25 mm. principal focal distance would have to be used, holding it at 33 mm. instead of 75 mm. from the object. And if placing the object at 75 mm. from a lens we had tried to enlarge it 5 times, we must have had recourse to a lens with a focus of 93·74 mm., and a virtual image five times as large as the object would have been formed not at 165 mm., nor at 217 mm., but at 375 mm. from the eye. In either case the observer would have been inconvenienced either by the too great proximity of the object to the lens or by the too great distance of the image from the eye. Brücke's idea therefore was excellent, and anatomists, physiologists, botanists, and naturalists, who continually use that small Microscope (microscopietto) of his, have justly, out of gratitude, called it "*Brücke's lens*."

But properly speaking, however, this lens is only a telescope of Lippersheim or of Janssen, and therefore a Microscope of Galileo. "It is clear (says Brücke himself) that it depends on the same principle as the Galilean telescope. The compound Microscope is an astronomical telescope whose objective has a very short focus; if instead one gives a very short focus to the objective of a Galilean telescope, we obtain the lens just described."

This frank confession of the celebrated physiologist proves with what candour he admitted having first used as a Microscope the Dutch telescope, and does not even allow the suspicion that he had had the least idea that Galileo had been before him even since 1610, that is, in the year of his wonderful discoveries in the heavens. We must not, however, deprive Brücke of the merit of having invented for the second time the Microscope, composed of a convex and a concave lens, all the more so, as his "working lens" is not intended to examine small objects or to see invisible things, but has been made and is used for anatomizing at some distance on those organs or those tissues which only demand a small enlargement to be sufficiently recognized.

APPENDIX.

Whilst this paper was being printed, Prof. Antonio Favaro with great kindness communicated to me an important passage, the better to confirm Galileo as the inventor of the compound Microscope. This passage is taken from certain 'Relazioni dei Viaggi' of Giovanni du Pont, Seigneur de Tarde, Canon of the Cathedral of Sarlat (Dordogne), 'Relazioni' which are in MS. in the National Library of Paris (Fonds Périgord, t. vi. cart. 20 and following). From these 'Relazioni' it appears that on Tuesday, November 11th, 1614, Tarde arrived at Florence, and on Wednesday the 12th went at once to visit Galileo, who was ill in bed. After having spoken with him about the Celesti discoveries, Tarde relates that Galileo told him :—

"Que le canon du télescope pour voir les estoiles n'est pas long plus de deux pieds, mais pour voir les objects qui nous sont fort proches et que nous ne pouvons voir à cause de leur petitesse, il faut que le canon aye deux ou trois brasses de longueur. Avec ce long canon il me dict avoir vu des mouches qui paraissent grandes comme un agneau et avoit appris qu'elles sont toutes couvertes de poils et ont des ongles fort pointues, par le moyen desquelles elles se soutiennent et cheminent sur le verre, quoique pendues à plomb, mettant la pointe de leur ongle dans les pores du verre." ("That the tube of a telescope for looking at the stars is no more than two feet in length, but to see objects which are very near, but which we cannot see on account of their small size, the tube must have two or three lengths. He tells me that with this long tube he has seen flies which look as big as a lamb, and had learned that they are all covered over with hair, and have very pointed nails, by means of which they keep themselves up and walk on glass, although hanging feet upwards, by inserting the point of their nail into the pores of the glass."

Therefore in 1614 Galileo had not forgotten his Microscope of 1610, and spoke of it pretty much in the same terms as he did afterwards in 1624 to Aleandro, Faber, and Cesi.

Another document, discovered by Prof. Favaro in the National Library at Florence (Cod. viii. F. 2), and by him also kindly passed on to me, speaks of three 'Occhiali detti di moltiplicatione' sent to the Grand Duke from countries beyond the mountains; and Agnolo Marzi Medici, author of the document, adds that he cannot say how these occhiali are made, being forbidden to do so, "because they want to see if Galileo will be able to discover it, as it is over a month since he is working at it, and so far nothing has been seen."

Now, although the document has no date, I think we may unhesitatingly attribute it to 1624, in the interval between the 11th of June, when Galileo left Rome to return to Florence, and the 5th of September, the date of Bartolomeo Imperiali's letter thanking Galileo for the gift of an occhialino. Galileo himself, writing to Cesi, September 23rd, excuses himself for the delay in sending the occhialino because he had not sooner brought it to perfection. Now, starting from Rome on the 15th of June, and this may be seen from a letter of Mario Guiducci, 11th of June, Galileo would not have reached Florence before the 21st June, and of one by Ciampoli ('Carteggio Galileano,' of Campori, p. 206), who thanks Galileo for having received news of his safe journey.

On the 9th August Antonio Santini wrote from Genoa to Galileo to thank him for having had the occhialino perfected for Imperiali (ib., p. 211), and as Santini answered a letter of Galileo of the 24th July, so we must suppose the occhialino to have been finished at least on that day. But if Imperiali's occhialino was finished on the 24th of July, we must admit that shortly after the middle of July Galileo had already found a means of bringing it to perfection. One can therefore conclude that Marzi-Medici's 'Scritto,' written a month after the time Galileo had set to speculate on and work at the occhialino, must be placed about the 15th July (a month, that is, after Galileo's arrival at Florence), when he was intending to reduce his Microscope to perfection.

On the other hand, the arrival in Florence of "occhiali di moltiplicatione" from regions beyond the mountains cannot be placed anterior to the introduction in Italy of Drebbel's Microscope, that is before 1624; and in 1624 Marzi-Medici, secretary to the Grand Duke Ferdinand II., and author of the document, was still alive, as it appears from a certain catalogue of Salvini that he died on the 31st October, 1628; we can therefore assign with certainty a date very near the 15th July, 1624, to the curious MS. discovered by Professor Favaro.

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(1) 'Bulletino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche' t. xiii. (August 1880, pp. 471–80). "Nuovo documento relativo alla invenzione dei Cannochiali Binocoli, con illustrazioni dal Prof. Gilberto Govi." (New document relating to the invention of Binocular Telescopes, with illustrations by Prof. Gilberto Govi.)

(2) Ibid., p. 475, lines 9, 12.

(3) 'Quatuor problematum quæ Martinus Horky contra nuntium sidereum de quatuor planetis novis disputando proposuit confutatio; by John Wodderborn, Scotchman. Patavii, Ex typographio Petri Marinelli, M.DC.X. superiorum permissu.' 1 vol. 4to, cart. 7 recto.

(4) Here is how he makes the Peripatetics, his contemporaries, speak in the famous 'Dialogo dei massimi sistemi':—"To speak with sincerity, I have not had the curiosity of reading those books, nor have I so far put any belief in the newly introduced Occhiale; indeed, following in the footsteps of other peripatetic philosophers, my colleagues, I have believed to be fallacious or a deception of glasses what others have admired as stupendous operations." ('Dialogo di Galileo Galilei Linceo ecc.,' Fiorenza, 1632, 4to, p. 328, lines 1–6. Galileo Opere, last edition of Florence, t. i. p. 366, lines 28-33.)

(5) Gal. Opere, t. viii. pp. 430–1. Ciampoli's letter of December 6th, 1619:—"Your Lordship's answer is expected with the greatest anxiety." Of course this is the answer to Padre Grassi's 'Libra astronomica.' Gal. Opere, t. viii. p. 436. Letter of Francesco Stelluti of January 27th, 1620:—"and because I have heard that your Holiness had already begun preparing the answer, therefore, &c., &c."

(6) Gal. Opere, t. vi. pp. 286–7. Galileo's letter to Federico Cesi, of October 19th, 1622:—"I have finally sent to the Illustrious Signor Don Virginio, the answer to Sarsi."

(7) "Il Saggiatore, nel quale con bilancia esquisita e giusta si ponderano le cose contenute nella Libra Astronomica e filosofica di Lotario Sarsi Sigensano, scritta in forma di lettera all Ill$^{mo.}$ et Reuer$^{mo.}$ Monsr$^{re.}$ D. Virginio Cesarini Acc$^{o.}$ Linceo M$^{o.}$ di Camera di N. S. dal Sig. Galileo Galilei Acc$^{o.}$ Linceo Nobile Fiorentino filosofo e Matematico Primario del Ser$^{mo.}$ Gran Duca di Toscana. In Roma 1623.' 1 vol. 4to.

Ib., p. 105, lines 28–35 and Galileo Opere, t. iv. p. 248, lines 21–28.

(8) The letters of Aleandro to Pieresc, and those of Peiresc to Aleandro have too much importance for the argument under discussion to allow of our omitting the extracts which treat of the Microscope. Peiresc's original letters are in the Barberinian Library, and the passages here reproduced have already been printed by the Abbé Rezzi in his "Memoria" (see note 16), which is amongst those in the 'Accademia pontificia dei nuovi Lincei,' for the year 1851. But Rezzi changed the spelling, and omitted some parts of them.

We have thought it useful to reproduce from the original, the parts in Peiresc's letters, preserving the form intact, and adding those extracts which Rezzi had suppressed.

Having then discovered among Pieresc's manuscripts, which are preserved in the National Library in Paris, some of the letters sent to the learned Frenchman by the Cardinal of Santa Susanna, and by Aleandro in answer to his, it has been thought right to detach from them the passages relating to the Microscope, and to intercalate them here between those of Peiresc, completing in this manner (as far as possible) the history of the origin of the Dutch Microscope, or Drebbel's Microscope, in Italy.

The extracts of Peiresc's letters are from the Codice N. A. 1975 of the Barberini Library. Those from the Cardinal of Santa Susanna's letters from the Codice No. 9536, Fond. franç. de la bibliothèque nationale de Paris. Those from Aleandro's letters from the Codice No. 9541, Fond. franç. of the same library. The different passages have been placed in order of time, to render more clearly the history of the facts relating to the invention of the Microscope.

Here are the documents. First letter of Peiresc to Aleandro:—

"Most illustrious and most honoured Sir,—Your Lordship will receive the present from the hand of Sig. G. Kuffler, of Cologne; a young man who is a good catholic, of much virtue and much modesty, whom you yourself will judge worthy of recommendation to virtuous people. He will be able to show your Lordship an *occhiale* or *telescope* of new invention, different from that of Galileo, with which he shows a flea as large as a locust, those that have no wings and are called crickets, and almost of the same shape, with its two arms and the other smaller legs, its head and almost all the rest of the body covered and armed with crusts or scales like locusts or small shrimps. The little insects which generate in cheese and which we call *Mitte*, *Mittoni*, or *Artiggioni*, which are so tiny that they almost seem like dust, become as large as flies without wings when seen with that instrument, and are so distinctly discerned that one recognizes them to have very long legs, a pointed head, and every part of the body quite distinct, making one admire in the highest degree the effects of divine providence, which was far more incomprehensible to us when that aid to our eyes was wanting. I thought that your Lordship would see it with pleasure, as did the Duke of Anjou, brother to His Majesty, and all the most curious persons of this town, and as out of this kingdom the King of England, Prince Maurice, and many other persons of great name have done; and I believe this invention will not be held in less esteem by people in your town, especially by the illustrious Cardinal of Santa Susanna, to whom I beg your Lordship to introduce this young man, as well as to the illustrious Cardinal your master, and the illustrious Cardinal Barberino, and others at your court, whom you will judge desirous of seeing it. He has some other inventions, which he will in time bring to light, and which may perhaps be even more successful, having learnt them from Sig. Cornelius Drubelsius, his relation, one of the cleverest men in this century in matters of mechanics, and who has built boats that float under water, mirrors that burn at several miles' distance, and other stupendous things; I will consider as done to me the favour and assistance he will receive from your Lordship, and I will consequently remain under proper obligation to you. With which without adding further I kiss your hands with all my heart, praying that Heaven may give you every perfect good. From Paris, 7th June, 1622.—Your most illustrious Lordship's affectionate servant, Di Peiresc."

From Peiresc to Aleandro:—

"Paris, 8th December, 1622.— . . . I am indeed sorry at the loss of poor Kuffler, and that unfortunately he should not have been able first to show the illustrious Cardinal of Santa Susanna and to your Lordship the marvellous effects of his occhiale. I am ashamed now of having written to you the details about it that I did, as I see you so far from being able to enjoy that instrument, as it is not credible unless one sees it as soon as spoken of. It would have been a great consolation for me if that relation of his who came from Naples could have made up for that deficiency. In the meanwhile I do not know how to thank you worthily for all the charity and liberality shown that poor man, as well after death as in life, and I beg you will receive the reimbursement from Sig. Eschinardo, and I will nevertheless remain much obliged to you for your great courtesy and singular promptness."

From Peiresc to Aleandro:—

"Paris, January 5th, 1623.—As to the occhiale which allows the most minute objects to be seen so many times enlarged, I am extremely sorry that the illustrious Cardinal of Santa Susanna and your Lordship never saw the effect. I kept one, which I have tried to have copied, and if I am successful, as I hope to be, I will not fail to send one at once to the said Cardinal; indeed, if I do not succeed in my attempt, I would rather resolve to send him mine, so that he may experience so miraculous an enjoyment of the sense of human sight, for otherwise I would pass as an impostor for having written what I first wrote to you on the subject, if I did not make him see it and touch it, so to say, and I would deserve to lose credit in the future."

From Peiresc to Aleandro:—

"Paris, August 14th, 1623.—I wrote to your Lordship by Father Dom. Gio. di San Paulo Vassano, in the beginning of July, a letter to be delivered in person with the occhiale by Drebelsius which I had received from Kuffler, together with another smaller occhiale most easily worked, having shown him how to use it, so that it might be easier for your Lordship to explain it to the illustrious Cardinal of Santa Susanna; and I thought that he must have already arrived, or be very near to Rome. But now I am assured that he has remained half-way on account of the return on this side of the mountains of the Father General of that Order, which displeases me extremely. We shall have to await the effect of fortune which seems to have persecuted this poor instrument."

From the Cardinal of Santa Susanna to Peiresc:—

"Rome, September 16th, 1623.—I would have been very happy to receive the two occhiali which you had entrusted to Father D. Giovanni, but which I believe will not be brought by the Father, and nevertheless I wish that my obligations to you be increased, &c., &c."

From the Cardinal of Santa Susanna to Peiresc:—

"Rome, September 25th, 1623.—About Father D. Giov. di San Paolo Vassano, who was to have brought the Kufflerian occhiale, I never heard further than what your Lordship wrote me, and provided he arrives some day, it will matter little, although he may delay some months."

From Peiresc to Aleandro:—

"Most Illustrious and Honoured Sir,—There has just now reached me a little box from Father Vassano, containing the occhiale with his letters, and at the same time the Avignon courier passing, I did not wish to let him go by without sending you the said little box. Your Lordship will do me the kindness to receive it and take the occhiale to the Illustrious Cardinal of Santa Susanna and show him the use of it, if you can put it together by what I wrote concerning it; there were other letters of introduction for the said Father, to different friends, to whom I believe I mentioned the occhiale, thinking that the Father could show it to all. I do not know whether they will be in the box or not, having no time to look it through more particularly. Your Lordship will be able to send them if so pleases you, by making the occhiale the excuse; I think I wrote about it to his Holiness at the time he was only a Cardinal, thinking he might experience pleasure in seeing the said occhiale, and perhaps it will be better not to send him the letter, in order not to oblige the Cardinal of Santa Susanna to send the occhiale I had given him, that he may not run the risk of having to make a gift of it. I leave all to your discretion and many times kiss your hands. Aix, November 17th, 1623.—Your most Illustrious Lordship's affectionate and grateful servant, Di Peiresc."

(On the margin of the leaf on the left and across.) "My secretary has just assured me that I wrote nothing about the occhiale to the Illustrious Cardinal Barberino, and that I only recommended Father Vassano, so that it does not matter whether the letter is given or not."

From Peiresc to Aleandro:—

"Aix, 7th December, 1623.—Most Illustrious and Honoured Sir,—The ordinary courier to Avignon was passing by this town in the greatest hurry at the very moment that a box from the Rev. Father Dom. Giov. di San Paolo was being consigned to me, containing the occhiale and the letters accompanying it. Which box I closed at once, looking at nothing but the Father's letter, and I consigned the whole to the above mentioned courier, who persisted in going on his way and scarcely allowed me to write two lines to your Lordship, whilst another person was closing the box. I recommended the same to Messrs. Otto. and M. Anto. Lumaga of Genoa, to whom your Lordship may henceforth forward whatever you wish to send me, that way being shorter than the route by Lyons. The same courier passed again last Sunday, and he brought me an answer from Genoa, from those Messrs. Lumaga, that the box had arrived in good condition, and that they had consigned it to a courier, a friend of theirs, to take it to your Lordship or to Sig. Eschinardo. I rejoice in believing that it has now reached you, and that your Lordship will have found out how the said occhiale can be used, and especially the little one, which is very easily used and has an effect not far inferior to the large occhiale."

Letter of the Cardinal of Santa Susanna to Peiresc:—

"Rome, December 26th, 1623.—Most Illustrious and Revered Sir,—I have to hand two of your Lordship's letters, the one of which represented to me the good state of your health, since you have retired from exercising your charge in the Parliament of Paris, for which I have felt the comfort that becomes the great affection I bear you, and the continual desire which I have for your welfare; the other has been brought to me with the occhiale; how dear this is to me your Lordship will understand by the desire with which I expected it, expressed to you in my letters. I would like you to recognize this fact more thoroughly by some act of mine in your service. But until an opportunity to do so is given to me, I will beg you to be satisfied with my thanks, which I now here render you for your courtesy. I will experiment on the occhiale with Signor Aleandro, and I will make use of this beautiful invention. May the Lord preserve and prosper your Lordship as I desire it. D.V.S. Rome, xxvj. December, 1623.—At your service, S. Car. di S. Susanna."

Here there comes, in the series of letters from Peiresc to Aleandro, a letter from Aix of January 12th, 1624, in which Peiresc mentions again the courier of Avignon, who took the box with the occhiali, as he speaks of it again in another letter of February 18th, but neither one nor the other containing new particulars concerning this subject, we have thought it useless to publish them. Between these two letters must be placed the following from Girolamo Aleandro to Peiresc :—

"Rome, February 2nd, 1624.— . . . With the same letter of the 2nd I received the box with the occhiali, which I took at once to the Cardinal of Santa Susanna, and I left in his hand your Lordship's old letter in which you wrote in what way they were to be used. It was easy to set up the little one, but we have not yet found the way of using the large one, although we had the help of mathematicians, and we have feared that in some part it is out of order. But the Cardinal of Santa Susanna will have written to you more diffusely on all this. . . ."

From Peiresc to Aleandro :—

"Aix, March 3rd, 1624.—I am very much surprised that you have not managed the large occhiale; if the glasses are not broken it is easy to find their proportion. I will await the more ample relation which you tell me will be sent me by the Illustrious Cardinal of Santa Susanna, in order to answer the difficulties and give some means of obviating them, so that the instrument may succeed. The greatest difficulty to the most perfect success lies in the movable plate upon which the object is placed, so as to keep it motionless under the point at which the line which passes from the eye through the centre of the two glasses terminates. For, when once one has learnt the use of it, it is operated most easily and with great pleasure and delight; one sees a tiny live animal walking and one retains it precisely under the line by moving the little plate contrariwise to the place towards which the insect is directing itself. Because the effect of the occhiale is to show the object upside down, and to cause the real motion of the little animal to seem contrary; as for example, if it be going from east to west it will appear to go from west to east. As to the distance of the glasses from each other, there are two limits out of which they do not make any considerable effect of increase and greater or lesser distinctness. And as to the distance between the object and the first glass, it must likewise be greater or less, according to that of the glasses from one another: that is, if the distance of the glasses between each other is the greater, the distance of the object must be less, and as you decrease the distance between the glasses, so must you increase the distance of the object."

From Aleandro to Peiresc :—

"Rome, 29th March, 1624.—The large occhiale is unbroken, but we cannot find a way of adjusting it rightly, because although we have directed the opening as we ought to have done towards the object placed upon the little plate, and we have also discovered the magnification, yet we did not see it distinctly, though your Lordship affirmed that it showed things more distinctly than the little one. We shall go on trying it until we find the way. But it is a long time since I have seen the Cardinal of S. Susanna. . . ."

From Peiresc to Aleandro :—

"Aix, 15th April, 1624.—Postscript.—Having remembered that Signor Melano, bearer of the present, has formerly seen in my hand the occhiale of the Illustrious Cardinal of S. Susanna, I have gone over with him the way to work it, and if your Lordship will let him see the occhiale again he will try it, and can direct your Lordship and any one it may please you to show it to after the said Illustrious Sig^r."

From Peiresc to Aleandro :—

"Aix, 10th and 17th May, 1624.—It is true that I wrote to you of the large occhiale that one saw the object clearer than in the little one, but to have the full effect of it, the object must be lighted up by the sun, otherwise it remains too dark. But in the sun you will see a stupendous effect, when you have found the way to use the instrument."

From Aleandro to Peiresc :—

"Rome, 24th May, 1624.— . . . Signor Melano, engraver on copper, came afterwards to see me with your Lordship's letter of the 15th, and I offered to serve him and recommend him to Villamena, Tempesta, and to whomever he liked. He told me he would return to see me, but I have not seen him since. I will also take him to the Cardinal of Santa Susanna. Galileo has been here these last few days, and at once found how the occhiale was to be used, but we don't think we see things very clearly and we will try with Melano.

Galileo told me that he had discovered an occhiale which magnified these small things perhaps fifty thousand times, so that a fly is seen as large as a hen. He remained here a few days, and returned to Florence. . . ."

Galileo left Rome only on the 11th June, but probably Aleandro had not seen him after that visit to the Cardinal, and therefore thought he was gone.

From Peiresc to Aleandro:—

"Aix, July 1st, 1624.—As to the occhiale, I am pleased that Signor Galileo understood it, but I am sorry that you should not have had as clear an effect as it gives in its proper adjustment, if the object be lighted up by the rays of the sun. Perhaps Signor Melano will be of some use to you if you will try him. In the meanwhile I thank you for the kindness shown to Signor Melano. But the occhiale mentioned by Signor Galileo, which makes flies as large as hens, is of the same invention as this one, of which the author made a copy for the Archduke Albert, of pious memory, which used to be placed on the ground, when a fly was seen the size of a hen and the instrument was no higher than an ordinary dining-table."

(9) Rezzi (see note 16), speaking (p. 102) of the Cardinal of Santa Susanna, calls him Girolamo Rusticucci, whilst in 1622 Scipione Cobellucci, from Viterbo, was the Cardinal bearing that title, having been made cardinal by Paul V. on the 19th September, 1616. Cobellucci died on the 29th June, 1626.

(10) Don Baldassare Boncompagni, with that great kindness which he has always shown me, has generously allowed me to make notes of all those facts which might be useful to me, from the very precious collection of MSS. which he possesses, and for a part of which there is a printed catalogue, compiled with great care and erudition by Sig. Enrico Narducci. In this collection is to be found a volume entitled, 'Lettere di molti accademici Lyncei scritte al Sig. Principe Cesi fondre. di detta Accademia'; it is from this volume that I have extracted the passage of Faber's letter reported in the text, and several other extracts of letters which are also here reproduced, and which are indicated as drawn from the Codice Boncompagni.

(11) Cardinal Zollern (Itelio Federico, Count of), made cardinal by Paul V. on January 11th, 1621, received the hat from Gregory XV. on November 15th, and the title of San Lorenzo in Panisperna, December 15th of the same year. He died on the 19th September, 1626. at Osnabrück, where he was bishop.

(12) As to Galileo's Microscope, which he asserted enlarged objects 50,000 times (in volume that is, 36 times in diameter), we have no other data except this of its magnifying power, and (from one of Peiresc's letters), the distance from the object to the ocular, a distance pretty nearly equal to the height of a dining table (which is generally 80 centimetres). This is supposing that Galileo's "Occhialino" of 1610, and the Microscope mentioned by Peiresc were one and the same thing. Making use of these two indications, and the distance of the object from the objective being taken arbitrarily, we can calculate its focal length. . . .

Galileo could therefore very well have constructed in 1610 a Microscope magnifying 36 times, with the concave ocular 80 centimetres from the place occupied by the object. The length of the Microscope, that is, the distance of the objective from the ocular, would have been 40 centimetres.

(13) Here are the books in which the different letters quoted in the text are to be found.

Letter of Bartolomeo Imperiali, Gal. Opere, t. ix. pp. 64–5; of Galileo to Federico Cesi, Gal. Opere, t. vi. pp. 297–8; Federico Cesi to Galileo, Gal. Opere, t. ix. p. 71; Bartolomeo Balbi to Galileo, 'Lettere inedite a Galileo Galilei raccolte dal Dott. Arturo Wolynski,' Firenze, 1872, letter 126, p. 75; of Galileo to Cesare Marsili, Gal. Opere, t. vi. p. 301.

(14) 'Nova Plantarum, Animalium et Mineralium Mexicanorum Historia, a Francisco Hernandez Medico in Indiis præstantissimo primum compilata, dein a Nardo Antonio Reccho in volumen digesta, a Jo. Terentio, Jo. Fabro, et Fabio Columna Lynceis, notis et additionibus longe doctissimis illustrata. Cui demum accessere aliquot ex Principis Federici Cæsii Frontispiciis Theatri naturalis Phytosophicæ Tabulæ, una cum quampluribus Iconibus, ad octingentas quibus singula contemplanda graphice exhibentur. Romæ, MDCLI. sumptibus Blasij deuersini et Zanobij Masotti Bibliopolarum. Typis Vitalis Mascardi.' 1 vol. fol.

The title of the edition of 1630 was rather different, and appears on the second leaf of the volume, engraved on copper by Federico Greuter. Omitting the details relating to the different writers of the work, this title is as follows:—

'Rerum Medicarum Novæ Hispaniæ Thesaurus, seu Plantarum, Animalium, Mineralium Mexicanorum Historia. Romæ, ex typographeio Jacobi Mascardi, MDCXXX.' To this original date were added in 1651 the numerals XXI. to compose the new date. In the frontispiece (engraved on copper) of 1630, Joanne Terrentio is correctly written, but in the frontispiece to the print of 1651 is changed to Terentio.

(15) The "ante pauculos dies" placed here by Faber, must doubtless refer to the date of the preface placed by him at the beginning of his work; which date is indicated thus by him: "Romæ e musæo nostro ad Pantheon Agrippæ ipsis Kalend. Januarij Anni solemnis 1625." From this it appears that Faber, who had seen Galileo's Microscopes in May 1624, only became acquainted with those of the two Germans at the end of the same year.

(16) 'Atti dell' Accademia Pontificia de' nuovi Lincei, pubblicati conforme alla decisione accademica del 22 dicembre 1850 e compilati dal Segretario T. V. Anno V (1851-1852).' Roma, 1852, 4to. Ib., pp. 98-140. 'Ottica. Sulla invenzione del microscopio. Lettera del prof. D. Luigi Maria Rezzi bibliotecario corsiniano e accademico linceo onorario al ch. Sig. D. Baldassare de' Principi Boncompagni accademico linceo ordinario. Giuntovi una notizia sulle considerazioni al Tasso attribute a Galileo Galilei, e sul dubbio se Alessandro Adinari fosse o no Accademico linceo.'

(17) Venturi (G. Batt.), 'Memorie e lettere inedite finora o disperse di Galileo Galilei ordinate ed illustrate con annotazioni ecc.' Modena, 1818, 2 vol. 4to.; vol. i. pp. 128-9.

(18) Galileo, Opere, t. viii. p. 406.

(19) Omitted.

(20) 'L. Annei Senecæ ad Lucilium, Naturalium quæstionum libri,' lib. i. vi. 5:—"Litteræ quamvis minutæ et obscuræ, per vitream pilam aqua plenam majores clarioresque cernuntur. Poma formosiora quam sint videntur, si innatant vitro."

From different passages, however, of Seneca, and of other ancient writers, one can easily gather that the enlargement which is here mentioned was by them attributed, not to the shape of the transparent means (spherical or lenticular, &c.), but to the density of these media with respect to the air, by which, according to them, the appearance of objects was increased whatever the shape of the transparent and dense body through which they were looked at. And it was probably owing to this persuasion that the ancients were ignorant of the effects of lenses, or did not know how to use them.

(21) 'Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche,' t. iv. (May–June 1871) p. 165. "Sur des Instruments d'optique faussement attribués aux anciens par quelques savants modernes; par Th. Henri Martin, doyen de la Faculté des Lettres de Rennes, Membre de l'Institut."

(22) 'C. Suetonii Tranquilli Duodecim Cæsares, Nero, Claudius,' li.

(23) 'L' occhiale all' occhio, Dioptrica patrica del Co. Carlo Antonio Manzini dottore Collegiato, etc. Which treats of light, refraction of rays, the eye, vision, and of the auxiliaries which may be given to the eyes to see the almost impossible. Where besides are explained the practical rules for making glasses for every sight, and telescopes with which to examine the planets and the fixed stars on sea, on land, and others to magnify a thousand times the smallest near object.' Bologna, 1660, 1 vol. 4to, pp. 98 and following.

(24) Omitted.

(25) 'Delle Gemme, notizie raccolte da Augusto Castellani.' Firenze, 1870, 1 vol. 8vo, p. 208. 'Traité complet des pierres précieuses, etc., par Charles Barbot,' Paris, 1858, 1 vol. 8vo, p. 320.

(26) 'Fratris Rogeri Bacon, ordinis minorum, Opus majus ad Clementem quartum Pontificem Romanum, ex MS. Codice Dublinensi, cum aliis quibusdam collato, nunc primum edidit S. Jebb, M.D.' Londini, 1733, 1 vol. fol. This book was presented to Clement IV. in 1269. Here are the most important passages relating to lenses (partis v. part. iii. distinctio ii. caput iv. p. 352, lines 23-6 and 31-3):—

"Si vero homo aspiciat literas et alias res minutas per medium cristalli, vel vitri vel alterius perspicui *suppositi* (this must be an ill-read abbreviation, and which must be read *superpositi*) literis et sit portio minor sphæræ, cuius convexitas sit versus oculum, et oculus in aere, melius videbit literas, et apparebunt ei maiores . . . et ideo hoc instrumentum est utile senibus et habentibus oculos debiles. Nam literam quantumcumque parvam possunt videre in sufficienti magnitudine."

Ibid., Distinct. Ultima, cap. i. p. 357, lines 25-41:—

"De visione fracta maiora sunt, nam de facili patet per canones supradictos, quod maxima possunt apparere minima, et e contra, et longe distantia videbuntur propinquissime et e converso. Nam possumus sic figurare perspicua, et taliter ea ordinare respectu nostri visus et rerum, quod frangentur radii et flectentur quorumcumque volverimus ut sub quocumque angulo volverimus videbimus rem prope vel longe, et sic ex incredibili distantia legerimus literas minutissimas et pulveres ac arenas numeraverimus propter magnitudinem anguli sub quo videremus, et maxima corpora de prope vix videremus propter parvitatem anguli sub quo videremus; nam distantia non facit ad hujusmodi visiones nisi per accidens, sed quantitas anguli. Et sic posset puer apparere gigas, et unus homo videri mons, et in quacunque quantitate, secundum quod possemus hominem videre sub angulo tanto sicut montem, et prope ut volumus et sic parvus exercitus videretur maximus, et longe positus appareret prope, et e contra; sic etiam faceremus solem et lunam et stellas descendere secundum apparentiam hic inferius, et similiter super capita inimicorum apparere, et multa consimilia, ut animus mortalis ignorans veritatem non posset sustinere."

(27) 'Monografia della Vetraria Veneziana e Muranese,' Venezia, 1874, 1 vol. 8vo. Ibid., parte antica, "Sulle origini e sullo svolgimento della vetraria Veneziana e Muranese," by Bartolomeo Cecchetti, pp. 12 and 13.

(28) D. Nicolai de Cusa Cardinalis etc. Opera. Basileæ, 1565, 1 vol. fol. Ibid., p. 267.

"Liber qui inscribitur de Beryllo incipit. Cap. ii. Beryllus, lapis est lucidus, albus et transparens cui datur forma, concava pariter et concava, et per ipsum videns, attingit prius invisibile."

(29) Littré, at the word *Lunette*, in the historical part of his dictionary, quotes a note of the sixteenth century reported by De la Borde in his work, 'Sur les Emaux' (p. 164), and that is the note reported in the text.

(30) 'Hieronimi Sirturi Mediolanensis Telescopium, sive Ars perficiendi novum illud Galilæi visorium instrumentum ad sydera, in tres partes divisa; quarum prima exactissimam perspicillorum artem tradit, secunda Telescopii Galilæi absolutam constructionem, et artem aperte docet. Tertia alterius Telescopii faciliorem usum; et admirandi sui adinventi arcanum patefacit. Ad serenissimum Cosimum II. magnum Etruriæ Ducem. Francofurti, Typis Pauli Jacobi, impensis Lucæ Jennis, 1618,' 4to (82 pp. and 2 pls.). The measures of the lenses indicated in the text are given by the figure on the large table intercalated after p. 18 in Sirturo's pamphlet, and seem derived from the *Braccio da panno* (yard measure for cloth) of Venice of 683 mm.

(31) 'Jo. Bapt. Portæ Neapolitani Magiæ Naturalis libri xx. ab ipso Authore expurgati, et superaucti, in quibus scientiarum naturalium divitiæ et delitiæ demonstrantur. . . . Neapoli, apud Horatium Salvianum, D.D.LXXXVIIII.' (1589), 4to.

Ib., lib. xvii. cap. x., xi., xii., xiii., and cap. xxi. pp. 269–71, and pp. 278–9.

No reference of Porta relating to lenses is to be found in the first edition of the Magia, which is of the year 1558.

'Magiæ Naturalis sive de Miraculis rerum naturalium libri iiii. Io. Baptista Porta Neapolitano Autore. Neapoli, apud Matthiam Cancer, M.D.LVIII. cum gratia et privilegio per decennium.' 1 vol. fol.

The things written by Porta about lenses in his work, 'Joan. Baptiæ Portæ Neap. De refractione optices parte. Libri novem. Ex officina Horatii Salviani. Neapoli apud Io. Jacobum Carlinum et Antonium Pacem,' 1 vol. 4to, have no scientific value whatever.

Ib., lib. viii. pp. 173–88.

(32) Codice Boncompagni: 'Lettere di Molti Accademici Lyncei ecc.,' cart. 354 recto. Letter of Nicolò Antonio Stelliola Lynceo to Prince Cesi, written from Naples on the 10th of April, 1615:—

"I will not now withhold what happened to me as to my Academic Brother Giov. Battista della Porta of holy memory: it is that on visiting him two days before he took to his bed in this his last illness, he said to me that the enterprise of the Telescope had killed him; being, as he said, the most difficult and arduous one which ever he had undertaken."

Let it be noticed that before the death of Porta, which happened on the 4th February, 1615, Kepler's two works had been published: 'Ad Vitellionem Paralipomena' in 1604, and 'Dioptrice' in 1611, in which the doctrine of lenses and telescopes was almost completely worked out.

(33) 'Considerazioni d'Alimberto Mauri sopra alcuni luoghi del Discorso di Lodovico delle Colombe intorno alla stella apparita l'ottobre dell'anno 1604. In Firenze appresso Gio. Antonio Caneo, 1606,' 4to.

(34) 'Galileo Galilei ed il Dialogo de Acco di Ronchiti da Bruzene, ecc. Studi

e richerche di Antonio Favaro.' Venezia, 1881, 8vo. In this pamphlet is at p. 82 a letter of Lodovico delle Colombe, written to Galileo on the 24th June, 1619, which begins thus:—

"It is true that, during the first days after the publication of Mauri's invective against me, I suspected on account of certain rumours and conjectures, which I found afterwards to be groundless, that you had taken part in it with him: but the excellent Sig. Giov. Battista Amadori assured me from your lordship's own words that such was in nowise the case."

(35) "Vedi F. Giordano predica del di 23 di Febbraio, 1305." (This note is by Mauri himself.)

(36) 'Discorso di Lodovico delle Colombe,' in which he shows that the new star which appeared in October 1604 in Sagittarius is not a comet, nor a star newly generated or created, but one of those which were in the heavens from the beginning, and that this is conformable to true philosophy, theology, and astronomical demonstrations. In Florence, in the printing office de' Giunti, 1606, 4to. Ibid., pp. 18, 37, and 48.

(37) 'Annales de Chimie et de Physique,' 5me série, t. xv. (1878), pp. 563–73; "De la Mesure du Grossissement dans les Instruments d'Optique, par M. G. Govi."

(38) Torricelli was the first to give an unhoped-for perfection to the simple Microscope, by suggesting the substitution of little globes or, as he called them, little pearls of glass, fused by the enamelling lamp into the very small lenticular glasses, which at that time no one had yet begun to work with emery in iron or bronze moulds.

He sent the news to F. Bonaventura Cavalieri, who, on the 15th of March, 1644, speaking of the telescope lenses perfected by Torricelli and of these "little pearls" of his, wrote him thus:—

"I hear by your letter of the marvellous operation of your glasses, and rejoice much with you. I see that you wish to leave to none any cause of glory in this most noble instrument, for with the vigour of your genius you have reached the minimum and maximum, quod sic, as philosophers say, and you have shown yourself great no less in the small than in the large parts of such instruments, for I no less admire these little glass globes, which I understand you have discovered, than this new invention which I hear you have just made."

After this letter, Torricelli sent some of his *perline* to Cavalieri, who thanked him in a letter of the 5th of April, 1644, showing himself highly satisfied with them.

See 'Lezioni Accademiche di Evangelista Torricelli.' Florence, 1715, 1 vol. 8vo. In the preface written by Tomaso Bonaventuri, pp. xvii. and xviii.

Father Athanasius Kircher has preserved the record of this invention of Torricelli, relating in division ii., paragraph v., cap. viii. of the second part of book x. of his work, 'Ars Magna Lucis et Umbræ,' published whilst Torricelli was still alive (Romæ, 1646, 2 vols. 4to. Ibid., vol. ii. p. 835), that these *perline* fixed at the extremity of a small tube were not more than 2·5 or 3 mm. in diameter, and added: "Huiusmodi tubulos Serenissimus Joannes Carolus Cardinalis Medicis * non ita pridem pro singulari suo erga hujusmodi studia affectu, mihi dono dedit; veraque isto experimento comperi, quæ sapientissimus princeps de ijs subinde narrabat."

(39) 'Fasti Consolari dell' Accademia Fiorentina, di Salvino Salvini, Console della medesima, Rettore generale dello Studio di Firenze. All' Altezza Reale del Serenissimo Giov. Gastone, Gran Principe di Toscana.' Florence, 1717, 1 vol. 4to.

Ibid., pp. 397–432. "Racconto istorico della vita del Sig. Galileo Galilei, nobil Fiorentino ecc. scritto da Vincenzio Viviani al Serenissimo Principe Leopoldo di Toscana, il dì 29 Aprile, 1654."

(40) 'Inedita Galilæiana. Frammenti tratti dalla Biblioteca Nazionale di Firenze pubblicati ed illustrati dal Prof. Antonio Favaro.' Venezia, 1880, 4to, pp. 35–43. Extracts from vol. xxi. delle Memorie dell' Istituto Veneto.

I quote this publication of the Chiarissimo Prof. Favaro rather than Viviani's former ones, or Nelli's, Venturi's, Alberi's, or any others, because in this is more completely and correctly reproduced the text of the inscription engraved by Viviani on the *Cartelloni* of his house.

(41) 'De vero Telescopii Inventore, cum brevi omnium conspiciliorum historia. Ubi de eorum confectione, ac usu seu de effectibus agitur novaque quædam circa ea proponuntur. Accessit etiam centuria observationum microscopicarum. Authore

* Giancarlo de' Medici, son of Cosimo II., born in 1611, made Cardinal in 1644, died on the 23rd January, 1663.

Petro Borello, Regis Christianissimi consiliario et medico ordinario. Hagæ Comitum, MDCLV.' 1 vol. 4to.

(42) 'Novæ cœlestium terrestriumque rerum observationes et fortasse hactenus non vulgatæ, a Francisco Fontana specillis a se inventis et ad summam perfectionem perductis, editæ. Neapoli, Mense Februarii, MDCXLVI.' 1 vol. 4to.

(43) 'Giornale dei Letterati. Roma, appresso li fratelli Pagliarini,' 4to, anno 1749, p. 324, 325, 326, anno 1750, pp. 63–4, anno 1751, pp. 94, 95, 254.

(44) Galileo is not named, although his Microscope is described in the two following works:

'Teorica degli Stromenti Ottici ecc. di Giovanni Santini.' Padova, 1828, 2 vols. 8vo, vol. ii. p. 174, § 340.

Gehler's (Johann Samuel Traugott) 'Physikalisches Wörterbuch, neu bearbeitet,' t. vi. part iii., Leipzig, 1837, 8vo. Ibid., Art. Mikroskop, pp. 2213–14.

(45) 'Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften,' vi. Band, 1. Heft, 1851. (Wien, 1851, 8vo. Ibid., Sitting of 8th May, 1851, pp. 554–5. See also 'Annales de Chimie et de Physique,' 3 série, t. xxxv., mai 1852, p. 127.

The President, Dr. Hudson, F.R.S.—At the June Meeting of the Society, the Fellows congratulated Dr. Hudson on his election as a Fellow of the Royal Society—a well-deserved honour. The following is a copy of Dr. Hudson's Certificate of Recommendation:—"Charles Thomas Hudson, M.A., LL.D. (Cantab.), President of the Royal Microscopical Society (1888). Was 15th Wrangler, 1852. Joint author of Hudson and Gosse's 'Rotifera.' Discoverer of *Pedalion mirum*, and of numerous new genera and species of Rotifera, described in papers published in the 'Journal of the Royal Microscopical Society,' 'Quarterly Journal of Microscopical Science,' and the 'Annals and Magazine of Natural History,' from 1869 to the present year. Specially distinguished for his knowledge of the Rotifera, concerning which he is the chief living authority." ["The genus *Pedalion*, discovered and described by Dr. Hudson, is one of the most remarkable and important contributions to animal morphology of the past twenty years."—E. R. L.]

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Cultivation of Bacillus tuberculosis on Potato.†—M. D. Barnsby confirms Pawlowsky's experiments on the cultivation of *Bacillus tuberculosis* on potato. The potatoes, sterilized at 100°, were kept in an incubator at a temperature varying from 38°–40° for ten days. Precautions were taken that the cultivations should be supplied with sufficient moisture. The author's experiments were undertaken for the purpose of seeking the bacillus in the urine of a child, suspected of renal tuberculosis. Control experiments were made on Nocard and Roux's glycerin-gelose. Positive results were obtained from both media.

(2) Preparing Objects.

New Methods for Preparing Nerve-cells.‡—Dr. L. von Thanhoffer recommends the following methods devised by him for demonstrating nerve-cells:—

(1) Rapid method.—A small piece of grey substance is pressed

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Annales de Micrographie, ii. (1889) pp. 362–3.

‡ Mathematische und Naturwissensch. Berichte aus Ungarn, vi. (1889) pp. 57–60.

CHARLES T. HUDSON,

M.A., LL.D. (Cantab.),

F.R.S.,

President of the Royal Microscopical Society,

1888.

between two cover-glasses, and when these have been drawn apart each is held over a gas or spirit-lamp flame until the layer of nerve-matter becomes of a blackish-brown colour, and a distinct smell of burning is perceived. The preparation is then mounted in xylol balsam or dammar.

In such preparations the nerve-cells and glia nuclei are seen to be of a dark-brown colour; the blood-vessels and their nuclei are also distinctly visible. The glia cells form a delicate reticulum, which connects the nerve-tubules with the blood-vessels and with the nerve-cells.

In order to ascertain if the reticulum was produced by a coagulation of the medullary substance, the fresh layer was soaked in ether for ten minutes, and the cover-glass then heated. It was found that the same reticulum appeared, but the cover-glass layer required to be treated for a longer time. It was afterwards found that if the cover-glasses were not separated for about one hour the preparations were more effective.

(2) Double cover-glass preparations.—A piece of grey substance about the size of a hemp-seed is pressed between two cover-glasses, between which are placed thin strips of tissue paper. The two cover-glasses, still sticking together, are then immersed in picrocarmine or in an aqueous solution of methylen-blue. The preparations required fifteen days to become perfectly stained. They are then dehydrated in absolute alcohol (four days), cleared up in oil of cloves, then placed for two days in xylol, and finally fixed to a slide by pouring some xylol dammar over them. When the dammar has dried the surface is cleaned.

Simple Method of freeing Frogs' Ova.*—Prof. F. Blochmann has discovered a simple method of freeing the ova of frogs from the gelatinous matter which surrounds them and from their envelope. A number of young eggs are preserved in chrom-osmic-acetic acid and then well washed in water. They are then placed in a shallow glass with a quantity of eau de Javelle diluted with three or four times its volume of water; from time to time the glass is shaken. In from a quarter to half an hour the eggs are quite free. The fluid must then be carefully drawn off, the eggs washed with water, and concentrated alcohol be gradually applied; the eggs should be kept in the dark, so as to remove the remains of the chromic acid. Eggs thus treated, and then stained with borax-carmine and cut into sections, show no signs of any injury. Prof. Blochmann believes that it will be possible to improve this method, which he commends to embryologists.

Investigation of Ova of Caprella ferox.†—Madlle. (Dr.) S. Pereyaslawzewa found, like M. Mayer, that the chorion covering the egg of Caprellidæ offers very great difficulties to the observer; like M. Mayer, she was tempted to renounce her word. Instead thereof, however, she devised a plan for detaching the compact chorion. The eggs are placed in a watch-glass with only sufficient water to keep them moist; boiling water is poured on them, and the chorion can then be removed with needles. The ova are then placed for from three to five hours in weak spirit, and then in absolute alcohol for twelve hours. Eggs prepared in

* Zool. Anzeig., xii. (1889) pp. 269-70.
† Bull. Soc. Imp. Nat. Moscou, 1888 (1889) pp. 582-3.

this way stain perfectly well; borax-carmine is to be preferred as a staining agent. If imbedded in paraffin they give excellent sections.

Preparing and Mounting Insects in Balsam.*—As it is difficult in preparing many of the smaller forms of insects to remove the débris from the surface of the specimen without injuring the delicate portions, Mr. Leckenby uses albumen, flowing the white of an egg over the object and immersing the slide in hot water till the albumen is coagulated, when it will generally crack open, and may be removed in two portions, carrying with it all the foreign matter and leaving the surface of the specimen perfectly clean. He strongly advocates thorough washing of the objects in running water and a final rinsing in either filtered or distilled water before placing in alcohol.

In mounting, the insect is placed under the cover-glass, arranged in proper shape, the clearing solution applied, and when sufficiently transparent the oil of cloves is cleared away and Canada balsam introduced at one edge of the cover-glass, the slide being held over the flame of a lamp to gently warm the balsam and allow it to flow in and displace the remaining oil of cloves. No annoyance need be felt at the presence of bubbles of air, as they will all gradually disappear. The mount, when filled with balsam, is placed in a warm oven or incubator and kept at a temperature of from 120° to 130° F. for twenty-four hours, when the balsam will be thoroughly hardened and all the air-bubbles driven out.

Mr. Leckenby does not advocate the use of volatile solvents with balsam, being convinced that a certain amount of gas is always retained in the mount in a latent state, requiring only a slight amount of heat to produce bubbles and disfigure the specimen.

Demonstration of Embryo-sac.†—Prof. D. H. Campbell recommends *Monotropa uniflora* for this purpose, in consequence of the comparatively large size of the ovules and embryo-sac. It is only necessary to strip away a small piece of the placenta with the adherent ovules, and mount in water or a 3 per cent. solution of sugar. In the latter fluid the ovules remain unchanged for several hours, and may be studied at leisure. The embryo-sac is covered by only two layers or cells, and these are perfectly colourless, not interfering in the slightest degree with the view of the embryo-sac.

Demonstration of Pollen-mother-cells and Pollen-tubes.‡—Prof. B. D. Halsted recommends for this purpose the young anthers of *Negundo aceroides*. A section of the anther-lobe will be found to be made up of a single ring of mother-cells, many of which are pear-shaped; and in these loose cells the four pollen-grains may be found in all stages of development. At first there is only the slightest differentiation of the protoplasm into four indistinct masses, which gradually become more evident, their arrangement in the mother-cell varying. Azorubin is excellent in weak solution for bringing out the young grains more prominently.

For the observation of the emission of pollen-tubes, the same writer § places pollen-grains in a solution of sugar varying between 10 and 75 per cent. Species of *Asclepias*, for which the most favourable strength

* Proc. San Francisco Micr. Soc., April 24th, 1889.
† Bot. Gazette, xiv. (1889) p. 83 (1 fig.).
‡ T. c., p. 109.
§ Bull. Torrey Bot. Club, xvi. (1889) pp. 130–1.

is 65 per cent., are well-suited for the purpose. The pollen-grains of *Tradescantia virginica* will produce tubes 100 μ long in two hours.

Continuity of Protoplasm in Plants.*—Mr. J. M. Coulter finds the cortex of the "buck-eye" (*Æsculus Pavia*) to be a favourable object for demonstrating the continuity of protoplasm. The strands which connect the protoplasts are here so large that they may be satisfactorily seen with a magnification of 250, and very well studied with one of 500 diameters, and in neither case is there any necessity for using an immersion objective. Mr. Coulter carefully slices the periderm from a twig about 1/4 to 1/2 in. in diameter, so as to expose the cortex; then makes a thin tangential section from the latter, and immerses in a solution of iodine in potassium iodide until it turns brown, washes to remove the excess of iodine, and mounts in water; at the edge of the cover-glass is then placed a drop of pure and two drops of 75 per cent. sulphuric acid; after this has been drawn under, the section is very thoroughly washed, and the water replaced by glycerin. Even a low power will now show the very much swollen and transparent walls crossed in every direction by protoplasmic strands connecting the contracted brown protoplasts. To make a permanent mount, it will be necessary to use some stain for the protoplasts and their connecting strands; otherwise the strands gradually become so transparent in the glycerin as to be almost invisible.

(4) Staining and Injecting.

Staining reagents for Wood.†—Dr. E. Nickel adduces reasons for the view that the so-called lignin-reaction of woody tissue is not due to the presence of a definite chemical compound, but to the aldehyde-constituents of the wood.

Staining of sections to show Micro-organisms in situ.‡—Dr. H. Kuhne opines that it is a mistake to use strong solutions of dyes to show the presence and position of micro-organisms in sections of animal tissue, as the differentiation is very difficult to bring off, owing to the compulsory use of decolorizing agents. He advises the employment of weak solutions, so that the tissues are not overstained, and to differentiate with acid or basic anilins.

The author states that he has given up the use of alcohol as a dehydrating agent, and uses only anilin oil for this purpose. In demonstrating the presence of bacteria in tissues, he first used anilins, basic and acid, dissolved in oil of cloves. This last reagent he has now discarded altogether in favour of anilin oil, which medium he now employs universally, i. e. stained or unstained, according as it is desired to use it as an extracting agent, a dehydrant, or for the purpose of double staining.

New and rapid method of staining the capsule of Bacillus pneumoniæ. §—Dr. U. Gabbi employs the following method for staining the capsule of *Bacillus Pneumoniæ* Frænkel. The sputum to be examined is spread on a cover-glass and quickly dried in a spirit-lamp flame. Two or three drops of a solution of 2·5 gr. carbolic acid, 1 gr. fuchsin, and 15 gr. alcohol in 100 gr. distilled water, are then dropped on the

* Bot. Gazette, xiv. (1889) pp. 82–3 (1 fig.).
† Bot. Centralbl., xxxviii, (1889) pp. 753–6.
‡ Annales de Micrographie, ii. (1889) pp. 358–61.
§ La Riforma Medica, 1889, No. 31.

preparation, where they are allowed to remain for one minute. It is then quickly washed in water, and in preparations thus treated the bacillus is stained dark red and its capsule bright red. The staining of the capsule vanishes if left too long in water.

Staining Tubercle Bacilli on Slides.*—The slide-method, says Dr. Schill, offers several advantages over the cover-glass method for staining bacilli. On account of its larger surface, larger areas of the same or of two to four different kinds of sputum can be simultaneously stained, decolorized, and after-stained. For examining the same sputum, only one cover-glass is needed, and this, when the first part of the sputum has been gone over, is pushed down the slide about the distance of the breadth of the cover by just running a droplet of water on to the edge of the cover-glass. In examining different sputa upon the same slide, the cover-glass is withdrawn after each examination, and wiped carefully before being placed upon the second sputum, &c. If a permanent preparation of the sputum is not required, the cover-glass should be cleaned in spirit directly the examination is over. Slides covered with sputum can be kept even without a cover-glass, if protected from dust, and are labelled. If repeated examination be required, a permanent preparation is made, or the slide made be examined anew with the cover-glass and drop of water. Owing to the greater thickness of the glass, heat is given off much more slowly after the slide has been drawn thrice through the flame. Hence the Ziehl-Neelsen solution need not be warmed if the staining solution be dropped on the slide while it is still hot.

With this method, nine or ten colonies from a plate cultivation can be examined at the same time.

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

New Medium for Mounting Pollens and Starches.†—Mr. A. P. Brown writes, that having experimented with all the various media recommended for the purpose, he has finally adopted the following for permanent mounts of pollens and starches :—℞ Selected gum arabic, 2 oz.; glycerin, distilled water, each $1\frac{1}{2}$ fl. oz. ; thymol, 1 gr. These are all placed in a wide-mouthed bottle, which is corked carefully to exclude dust, and placed in a warm situation. It takes several days to effect a perfect solution, the mixture being stirred up occasionally. When all is dissolved, strain through linen, and set aside the liquid about a week longer to get rid of air-bubbles, and to allow any small particles that may have passed through the strainer to settle to the bottom; or it can be filtered through absorbent cotton by using a funnel for hot filtration, which consists of a double tin case holding water, kept at the required temperature by a spirit-lamp placed under the projecting arm. A glass funnel fits inside the hot water-bath, a plug of absorbent cotton is placed in the funnel, and the solution is passed through it. After filtration it is best preserved in compressible tubes. The medium is the suggestion of M. Charles Bulloch, the well-known Chicago optician and microscopist.

Rest for Slides and for Cultivation Plates.‡—M. L. Malassez makes his rest for slides entirely of metal. It consists of two uprights united

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) p. 340.

† St. Louis Med. and Surg. Journ., lvi. (1889) pp. 288–9, from 'American Journal of Pharmacy.'

‡ Arch. de Physiol., viii. (1886) pp. 275–7 (1 fig.).

by two transverse pieces, and from the uprights proceed outwards in opposite directions two branches of which there are several tiers. At the end of each branch is a stop to prevent the slides from slipping off. The distance between the branches is such that the ends of the slides only just rest on them so that there is no fear of spoiling the preparations.

Rests of larger dimensions are made for special cultivations. For this purpose the plates or slides are hollowed out on their upper surface to prevent the nutritive medium from running off when liquefied by heat or micro-organisms. These slides are 10 cm. long and 5 cm. broad, and therefore can be examined with ordinary Microscopes without being obliged to be turned round. Both rests are intended to be covered over with a bell-jar.

Nitric Acid in Gelatin.*—Dr. R. J. Petri, who recently showed the presence of nitric acid and other adulterations in gelatin, now communicates the cause of its presence. It appears that caustic lime is used in the manufacture in order to get rid, by means of saponification, of any fatty matters. The excess of lime is then removed by means of water. But as a considerable quantity of lime still remains behind, this is neutralized with nitric acid. Hence the presence of nitrates and of lime.

(6) Miscellaneous.

Rosenbusch's Petrographical Tables, an aid to the Microscopical Determination of Rock-forming Minerals.—This is a translation,† by Dr. F. H. Hatch, of Prof. H. Rosenbusch's 'Hülfstabellen zur mikroskopischen Mineralbestimmung in Gesteinen.'

These useful tables contain, in handy form, convenient for reference, the most important physical and chemical properties of the principal rock-forming minerals. They constitute, in fact, a summary of the contents of the first volume of Prof. Rosenbusch's 'Mikroskopische Physiographie.'

The tables are arranged under three main divisions, viz. Table I., singly-refracting minerals; Table II., containing two subdivisions *a* and *b*; doubly-refracting uniaxial minerals; Table III., containing six subdivisions *a–f*, doubly-refracting biaxial minerals.

The several headings of the parallel columns forming each table are as follows:—Name of mineral; crystallographic system; cleavage under the three divisions of quality, direction, and angle; characteristic form; optical character (+ or −); principal zone or face; forms and optical character of principal zone; colour; pleochroism; index of refraction (n) and double refraction under the four divisions $n = \frac{\alpha + \beta + \gamma}{3}$, $\gamma - \alpha$, $\beta - \alpha, \gamma - \beta$; optic orientation; apparent optic axial angle; dispersion; specific gravity; behaviour with reagents; chemical composition; remarks.

New Method of Determining the Number of Micro-organisms in Air.‡—This new process, which was devised by Prof. T. Carnelly and Mr. T. Wilson, is a modification of Hesse's method, in which a flask is

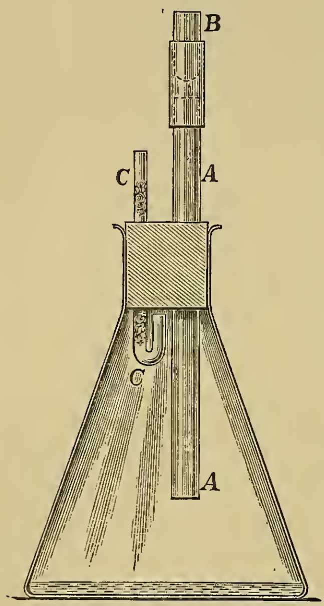
* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 679–80.

† 4to, London (Swan Sonnenschein & Co.) n. d., 3 tables and preface. Cf. Nature, xl. (1889) pp. 313–4.

‡ Proc. Roy. Soc. Lond., xliv. (1888) pp. 455–64 (1 fig.).

substituted for a tube. The flask is conical, and holds about half a litre, and is fitted with a two-holed indiarubber stopper. Through one hole passes the "entrance tube" A A, a glass tube about 8 in. long, and having an internal diameter of 3/8 in. It reaches about two-thirds of the way down the flask, and is closed at the outer end by a glass stopper B fitted on with a piece of indiarubber tubing. Into the other hole of the stopper is fitted the "exit tube" C C. This is a piece of glass tubing (1/4 in. diameter) bent round at the lower end, so that it opens in the neck of the flask just under the rubber stopper. It is open at both ends, but contains two cotton-wool plugs to prevent entrance of any micro-organisms from the outside.

Fig. 70.



Ten ccm. of Koch's pepton-gelatin are introduced into the flask, and the stopper tied on with copper wire. The flask is then steamed for an hour at 100° C., and on cooling, an even layer of gelatin is distributed over the bottom.

In taking a sample of air the aspirator is attached to the exit tube C, and the rubber tube and stopper B removed from A. A known volume of air is then drawn through the flask, after which the stopper is replaced. The microbes settle on the jelly, and having developed into colonies, may be counted in a few days. Counting may be facilitated by marking out the bottom of the flask in squares. The rate of aspiration adopted was 1 litre in three minutes. In order to prove the safety and certainty of this method, various tests, for which the original must be consulted, were applied.

The authors consider that their method is extremely safe, and possesses all the advantages and none of the disadvantages of Hesse's and Frankland's methods.

Value of Bacteriological Examination for Estimating the Purity of Drinking-Water.*—In a short review of the present condition of the question as to how far the bacteriological examination of water is of value in estimating its purity, Dr. Ordmann sums up very shortly the results of his own and others' experiments. It may be remembered that when plate cultivations were first used for the breeding of micro-organisms, much was expected of this method for determining the quality and characters of micro-organisms present in a given specimen of water. This expectation was not fulfilled, for it was found on the one hand, in water chemically good, that not unfrequently there were large quantities of micro-organisms present; and on the other, that in water chemically bad, it very frequently happened that but few micro-organisms developed. So that the author, while not depreciating the

* Zeitschr. f. Naturwiss., lxi. (1888) pp. 654–8.

value of a bacteriological examination of drinking-water, concludes that it is not safe to rely on it as a practical test both for the reasons given above, and also because the presence of micro-organisms is no test of impurity, since it is the opinion of some observers that many of these microbes are normal constituents of drinking-water. Much, too, is to be said against laying too much stress on the pathogenic character of the organisms when they are found to liquefy gelatin.

Apparatus for the Bacteriological Examination of Water.*—In order to distribute with regularity all the germs present in a specimen of water on the gelatin plate, and at the same time to be able to distinguish these from aerial impurities, M. Arloing has devised a complicated "analyser." A rectangular copper box, 250 cm. long, 85 cm. broad, and 36 cm. high, is so far closed on the short sides by two glass lids, movable on hinges, that there remains between them a space 7 cm. broad. The interspace can be closed by means of a piece of metal with a hole in the middle. To one of the small sides is fixed a support, on which a pipette is fixed, so that it can hang vertically down through the interspace passing through the aperture in the metal plate. The support, and with it the pipette, is able to be moved in the direction of the cleft by means of a screw arrangement. On the bottom of the box is a strip of brass for the reception of a glass plate, and which also by means of a screw is movable in the long axis of the box. The glass plates intended for the gelatin have raised edges, are 12 cm. long, 5 cm. broad, and divided into 60 squares of 1 sq. cm. each.

When water is to be tested, a gelatin plate is introduced, and the pipette filled with water to be examined. The latter is then allowed to fall drop-wise on the gelatin plate, so that every square space receives one drop. The plate is then removed to an incubator.

The advantages claimed for this apparatus are that the water is distributed regularly all over the plate, and that germs from the air are excluded.

Chemical and Bacteriological Examination of Water.†—Drs. F. Tiemann and A. Gärtner have just issued the third edition of Kubel-Tiemann's 'Introduction to the Examination of Water.' The present edition, which has been enlarged and thoroughly revised, is illustrated with many wood engravings, and ten chromolithographic plates. The work is divided into three parts. The first of these, for which Tiemann is responsible, is devoted to chemical examination; the second, which is the work of Gärtner, deals with the microscopical and bacteriological examination of water; while the third part, which is the joint work of both authors, sums up the results of the chemical and bacteriological experiences.

The book seems to have had considerable care bestowed upon it, and is rich in details which are useful to various classes of students interested in the conditions of water as considered from their different standpoints. Thus the chemist, the physician, and the trader obviously regard water in different lights, and these and other classes will find their requirements attended to in this work.

Diagrams of Microscopical Objects for Class Teaching.‡—Dr. L. Klein in a long article states that he has derived much advantage from

* Revue d'Hygiène, x. (1888) No. 6. † 8vo, Braunschweig, 1889.
‡ Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 18–32.

the use of diagrams of microscopical objects for class teaching. These diagrams are made in the usual manner with chalks, charcoal, and pigments. The only novelty in the paper is the suggestion that time may be saved by obtaining the image of an illustration in a book by placing the leaf in a magic lantern and throwing the image on the drawing paper.

Thallin, a new reagent for Lignin.*—The otherwise excellent reagent for lignin, phloroglucin, has the disadvantage that the stained preparations rapidly become colourless on exposure to light. Herr R. Hegler proposes as a substitute thallin, which is an extraordinarily delicate reagent for lignified tissue, is of very easy application and great persistence under the action of light, and possesses the additional advantage of presenting no reaction with coniferin. The section is placed first in pure alcohol, and then, in a watch-glass, in a concentrated solution of thallin-sulphate in dilute alcohol; all the lignified parts then assume a dark orange-yellow colour, which increases with the length of the immersion, and is not lost after exposure to the light for months, while the cellulose and cork membranes remain perfectly colourless. With long immersion the cellulose and cork tissues assume a slight rose colour. 1 ccm. of a 1 per cent. solution, containing 0·001 gr. of thallin-sulphate, produces a strong reaction with pine-wood; and this is by no means the limit of the sensitiveness. With regard to the reaction of the various lignin-reagents on the two substances which are the constant associates of lignified tissues, vanillin and coniferin,—thallin reacts with vanillin but not with coniferin, phenol-hydrochloric acid with coniferin but not with vanillin, all the other lignin-reagents with both.

New micro-chemical reagent for Tannin.†—According to M. L. Braemer there are objections to all the reagents at present used for the detection of tannin; ammonium molybdate has the disadvantage that its precipitates with tannic acid are soluble in water and dilute acids, and the reagent itself has but little persistency. The author proposes as a substitute a mixture of 1 gr. sodium tungstate and 2 gr. sodium acetate in about 10 ccm. of distilled water, which precipitates both tannic and gallic acid, but cannot be used to distinguish between these two. It does not precipitate albuminoids, nor other substances resembling tannin. By this reagent the presence of 0·00001 gr. of gallic acid can be detected.

Tests for Tannin.‡—In the account of his researches on the presence and distribution of tannin in the vegetable kingdom,§ Herr H. Moeller thus classifies and comments on the various chemical tests used for this substance.

(1) Iron-salts.—The great objection to the use of these reagents is that the compounds of iron and tannic acid are readily soluble in excess of the reagent, in weak acids, or in alkaline liquids. The last the author has observed only in the case of *Tussilago Farfara*, while in many cases the compounds in question are soluble in acids, especially in hydro-

* SB. Bot. Ver. München, March 11, 1889. See Bot. Centralbl., xxxviii. (1889) p. 616.

† Bull. Soc. Hist. Nat. Toulouse, 1889, Jan. 23, 4 pp. See Bot. Centralbl., xxxviii. (1889) p. 820.

‡ Ber. Deutsch. Bot. Gesell., vi. (1889) Gen.-Versamml.-Heft, pp. lxvii.–lxxi.

§ Cf. *ante*, p. 541.

chloric acid. Chloride of iron exhibits osmose freely in a dilute aqueous solution, but always has an acid reaction; when dry and dissolved in absolute ether, it is an exceedingly good reagent for tannin. Acetate of iron in the form of either *liquor ferri acetici* or *tinctura ferri acetici* gives a beautiful reaction; the former diffuses with great difficulty; the latter is preferable in many respects. Citric iron-ammonium oxide can only be used in a few cases, in consequence of its very slight diffusibility.

(2) Of oxidizing reagents, potassium bichromate gives a beautiful chestnut-brown precipitate. Its comparatively slight diffusibility can be increased by the addition of a few drops of acetic acid. It is probable that one product of the oxidation of tannin is purpuro-gallin or an allied substance, but the author believes that there are several kinds of purpuro-gallin, and that these result from the oxidation of different tannin acids in the plant. Ammonium molybdate (Gardiner's reagent) is the one recommended by the author as the best. It may be slightly alkalized by ammonia in order to increase its diffusibility; and the remaining cell-contents are then for the most part left unchanged. Dilute aqueous solutions of alkalies oxidize indirectly by the production of oxygen; but these reagents cannot be recommended, neither can the reaction with iodine.

New method of recognizing small quantities of Invertin.*—According to M. J. Costantin, *Bacillus phosphorescens* Hermes (*Micrococcus phosphorescens* Cohn, *M. Pflügeri* Ludwig), which is found on salt fish, possesses a phosphorescent property when it developes in glucose, but it loses this in the presence of saccharose. This property serves to detect invertin in small quantities. A decoction of the fish in sea-water is prepared, and 7 per cent. of gelatin added, which is mixed with the culture of the above mentioned bacillus. After coagulation there remains a luminous substratum; this, at the end of two or three days, shows great sensitiveness towards chemical agents. If saccharose be added to the gelatin, the luminosity does not change; but if a trace of invertin be added, it quickly forms a large luminous plate on the substratum.

* "J. C." in Morot's Journ. de Bot., iii. (1889) p. 32.

PROCEEDINGS OF THE SOCIETY.

Meeting of 12th June, 1889, at King's College, Strand, W.C., the President (Dr. C. T. Hudson, F.R.S.) in the Chair.

The Minutes of the meeting of 12th May last were read and confirmed, and were signed by the President.

The **List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Rosenbusch, H., Petrographical Tables. An Aid to the Microscopical Determination of Rock-forming Minerals. Translated and edited by Dr. F. H. Hatch. 3 tables and preface. (4to, London, n.d.) Swan Sonnenschein & Co.	*The Publishers.*
Slides (2), *Megalotrocha semibullata*	*Mr. V. Gunson Thorpe, Surg. R.N.*
Slides (2), *Asplanchna* n. sp. and *Lacinularia* n. sp.	*Mr. T. Whitelegge.*

The **President** said that the Fellows were aware of the necessity which had arisen of finding rooms for the Society in consequence of their having to vacate those at present in occupation at King's College, and he called upon the Secretary to make a statement as to the steps which had been taken by the Council in the matter.

Mr. Crisp said that, after some deliberation, the Council had decided upon taking rooms which had been offered to them at No. 20, Hanover Square. The house had been taken by the Medical and Chirurgical Society who intended to occupy the ground-floor and let off the rest to other Societies. The portions available were the first and second floors, with the use of a large meeting room which was to be built upon the garden at the back. They were not able to afford the rent asked for the first floor, and had therefore decided to take two rooms on the second floor —at the back, these being larger than the front. They were to have a lease of these for 21 years, and the rent was agreed at 130*l.* per annum, which sum would include cleaning, rates and taxes, and electric lighting. This rent was rather more than they were paying at the present time, but considering the difficulty of getting suitable accommodation, he thought the Fellows would have every reason to be satisfied, especially as the increased expense would only be about 20*l.*, and this would be met by the addition to their income from new Fellows during the year. They were not obliged to turn out of their present premises before next year, and as it would take some time to get the new ones ready, they would probably hold another annual meeting where they were.

Mr. Crisp called attention to a new homogeneous-immersion 1/12 in. objective by Messrs. Powell and Lealand, under which Mr. Powell was showing *Amphipleura pellucida* in a very satisfactory way. He must not say anything as to the price, but those who knew what it was might be tempted to conclude that they had been paying rather too much for that class of objective hitherto.

Mr. C. L. Curties exhibited a new 1/2 in. apochromatic objective by Zeiss, with a numerical aperture of 0·60. This was only the second of its kind which had reached this country, the other being in the hands of Mr. Nelson, who spoke very highly in praise of its performance. It was shown with an achromatic condenser designed by Prof. Abbe, who, he believed had been converted to adopting achromatism in the illuminator.

Mr. J. Mayall, junr., said that it was upon the occasion of his visit to Jena that he brought the attention of Prof. Abbe to bear upon the subject of the achromatic condenser, and having shown him the advantage obtained by its use he was in the end convinced of its value. The instrument used by Mr. Curties was an embodiment of the idea then discussed by Prof. Abbe, the first ones made being intended for use in photomicrography. It had an aperture very close upon unity, so that it had the maximum required for dry lenses. There was also an arrangement by which if it was required for use with other powers the front combination could be removed, and a larger field by that means obtained. There was one point in connection with the use of these condensers, which it seemed, from the work sometimes exhibited, needed to be rather plainly dwelt upon: this was that the light should always be accurately focused upon the plane of the object, otherwise the best results could not be obtained. There were, as they knew, both thin plates and thick plates upon which objects were mounted, and when an achromatic condenser was made for use with a thin plate, it was unfair to use it upon a thick one; the proper thickness must be considered if the best effect was desired, and it was very important, therefore, to note that the focusing should be accurately centered upon the plane of the object. The thickness could be altered, sometimes, by turning the slide over, or by putting additional pieces of thin glass temporarily above or below. Some manipulators had adopted that plan, but others did not seem sufficiently aware that the object was to give a very perfect image of the lamp-flame.

The President inquired whether these new condensers had a large head, or were coned down.

Mr. Mayall said that with so large an aperture as N.A. 1, the condenser had to come up almost in contact, and being designed to work with both medium and high powers the lenses had to be of large size.

The President thought it would in this way be only applicable to mounted objects, and not to live ones, especially as they wanted sometimes to reverse them.

Mr. Mayall thought this would apply to all condensers, but would depend upon the lenses in some degree. They had been very successful in Jena in obtaining long working distances for their objectives, one of 1/8 in. used by Dr. Dallinger had two or three times the working distance of those ordinarily made. This was due, no doubt, to the new glass, and also to the great care taken in the coning of the lenses as they lay one above the other.

Mr. Western exhibited a species of *Asplanchna*, which, he said, the President had been good enough to identify for him.

The President said that when Mr. Western showed him these specimens he recognized them at once as old friends from America, like some which had been sent to him in spirit. On first seeing them he thought they were *Ebbesbornii*, but the posterior end was more pointed, and the male had only two lateral humps, and not two under the neck as *Ebbesbornii*. In many respects *Asplanchna* was very perplexing and it seemed as if the males varied at different periods. He called attention to some rotifers exhibited by Mr. Rousselet with exceptionally good dark-ground illumination and inquired how it was obtained.

Mr. Rousselet said it was done with Abbe's ordinary condenser.

Mr. Crisp read a letter with reference to some lithographic drawings of microscopical objects made by a young lady, Miss C. E. H. Abrahall. The prints were handed round for inspection and were much approved.

Prof. S. P. Thompson's paper, "Note on Polarizing Apparatus for the Microscope" was read (*post*).

Surgeon V. Gunson Thorpe, R.N., read his paper, "Description of a new species of *Megalotrocha*" from Brisbane (*post*).

The President felt sure that the Fellows of the Society would be very much indebted to Surgeon Gunson Thorpe for bringing this subject before them. He had himself had the pleasure of corresponding with him upon these matters, and had been much struck by his power of observation and the skill which he had displayed in drawing what he had seen. The animal which had been described was not only new, but was remarkable in many points. It was found to be a swimming creature, but he doubted whether it was permanently so, because he thought the size seemed to indicate that it was a young form, and he had seen instances where a number of them, though quite free, would turn their tails together and form a cluster very much like *Conochilus*. He had never seen so large a cluster as seventy, described by Mr. Thorpe.

Mr. Thorpe said he had found one species which was much larger.

The President thought that the two animals differed in one or two points—first, in *Megalotrocha*, the squarish form of the corona was peculiar and as distinct as that of *Melicerta tubicolaria;* then the two knobs were not found in the same place, the eyes were also remarkable, and the trifid stem was also curious, like a club with three knobs. In *albo-flavicans* there was seen a remarkable habit of all the members of a group sweeping down together just as if a wave passed along them; in that motion the whole of the foot took part. It had also been noticed that when contracted the knobs or warts were always found at the top of the contracted part—that might be the use of them, so that they might protect from injury, something in the same way as the bosses upon a trunk. Unfortunately all these points were lost in the slide which Mr. Thorpe had brought with him, showing how necessary it was to see these things alive if they wished properly to understand them. There was also a slide exhibited in the room of *Lacinularia pedunculata*, showing the long stem very plainly. He had with him some small tubes containing specimens of this creature for distribution to those Fellows of the Society who were interested in the study.

Mr. Gunson Thorpe also called attention to a curious organism which he had found upon the surface of the sea, surrounded by a mass of sponge spicules and shells made into a kind of nest; its movement was rather slow, but it swam about quite freely.

The President thought it very curious; it appeared to be some kind of marine worm, something like the Caddis.

Prof. Bell said it was one of the most interesting marine objects he had seen lately, but he had not the faintest idea what it was, neither had he been able to find out anything about it from the sources of information which he had consulted. Mr. Thorpe had a number of drawings, and it might be worth while to insert a woodcut of this object in the Journal in the hope that some one seeing it might be able to give some information about it.

The President said he had brought to the meeting a somewhat rough model for the purpose of giving a true notion of what the head of a *Conochilus* was like. Most people knew the object very well, but many descriptions given—especially foreign ones—gave very misleading ideas of the structure. This he thought was perhaps mainly due to the use of one tube and the examination of the object by transmitted light by persons who did not know what the thing was, and had therefore resorted to the process of guessing what it was by focusing up and down upon it. When a man described a closed surface as an open one, and said there was one row of cilia when there were really two rows, it was clear that the object was not understood. Unless it was properly examined, it was a very difficult object to make out, and hence the mistakes made. The model was passed round for examination.

Mr. J. D. Hardy said it struck him as being somewhat different in form from what his own observations led him to suppose was the case. The opaque objects were for instance more upon the disc than appeared in his own drawings.

The President said he could answer for certainty that they were as shown on the model on the neck and shoulders—generally they were only seen through other portions.

Mr. Hardy could quite corroborate the statement as to the difficulty there was in drawing *Conochilus*.

Mr. Crisp said he was sure the Fellows would be glad to congratulate the President upon his recent election as a Fellow of the Royal Society. His qualifications as set out upon the certificate would perhaps interest the Fellows present, and he therefore read them to the meeting.

The President said that he thanked the Society very much for the manner in which they had received Mr. Crisp's very kind remarks.

The President said they were favoured that evening by the presence at the meeting, as a visitor, of Mr. J. Ferrier, ex-President of the Microscopical Society of Montreal.

Mr. Ferrier said it had given him great pleasure to be present at the meeting. Their Society in Montreal was not a very large one, having been originally formed as a club of twelve members, each of whom was privileged to bring three friends to the meetings. Dr. Carmichael was the President of the Society at the present time. He felt very much obliged to the Fellows for the kind reception they had given to him as a visitor from a kindred Society in a distant city.

Mr. E. M. Nelson's paper on "A means for the detection of Spurious Diffraction Images" was read.

Mr. T. F. Smith said he should like to have some demonstration from Mr. Nelson as to the doubling of the width of the grating, because he "held that if an object was delineated at all it was delineated correctly."

The President said there remained to him now only the pleasant task of wishing the Fellows of the Society a very happy vacation, expressing at the same time a hope that they would be able to bring something back with them of interest to future meetings.

The following Instruments, Objects, &c., were exhibited:—

Miss Abrahall:—Lithographic Drawings of microscopic objects.

Mr. C. L. Curties:—1/2 in. Apochromatic Objective by Zeiss, and Abbe Achromatic Condenser.

Dr. C. T. Hudson:—Model of *Conochilus.*

Mr. T. Powell:—1/12 in. Hom. Imm. Objective.

Mr. Gunson Thorpe:—Two Slides of *Megalotrocha semibullata.*

Mr. Western:—Slide of *Asplanchna* n. sp.

Mr. T. Whitelegge:—Slides of *Asplanchna* n. sp. and *Lacinularia* n. sp., and an unknown organism.

New Fellows:—The following were elected *Ordinary* Fellows:—Messrs. John Goodfellow, B. M. Winder, F.C.S., and Thomas Whitelegge.

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OF THE

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

Edited by

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FELLOWS OF THE SOCIETY.

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NOTE.—Plate X. issued herewith is in substitution for that issued with the August No., the figs. of which are incorrectly numbered.

CONTENTS.

SUMMARY OF CURRENT RESEARCHES, ETC.

MICROSCOPY—*continued from August No.*

OCTOBER 1889.

TRANSACTIONS OF THE SOCIETY—

SUMMARY OF CURRENT RESEARCHES.

ZOOLOGY.

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

α. Embryology.

β. Histology.

γ. General.

Mollusca.

γ. Gastropoda.

Molluscoida.

α. Tunicata.

β. Bryozoa.

Arthropoda.

α. Insecta.

(3) Structure of Tissues.

(4) Structure of Organs.

β. Physiology.

(1) Reproduction and Germination.

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

γ. General.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Muscineæ.

Algæ.

Fungi.

Mycetozoa.

Protophyta.

α. Schizophyceæ.

β. Schizomycetes.

MICROSCOPY.

α. Instruments, Accessories, &c.

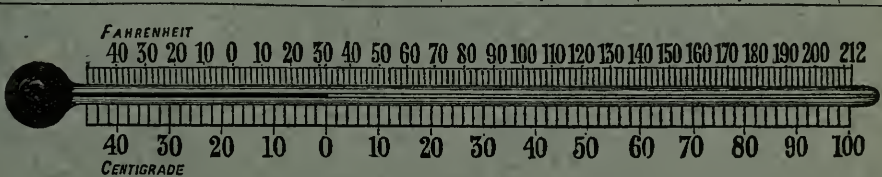
(1) Stands.

APERTURE TABLE.

Numerical Aperture. (n sin $u = a$.)	Corresponding Angle ($2u$) for Air ($n = 1\cdot00$).	Water ($n = 1\cdot33$).	*Homogeneous Immersion* ($n = 1\cdot52$).	Limit of Resolving Power, in Lines to an Inch. White Light. ($\lambda = 0\cdot5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0\cdot4861\ \mu$, Line F.)	Photography. ($\lambda = 0\cdot4000\ \mu$, near Line h.)	Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	136° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

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



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105	1½ inch	23	2 10 0	30	48	90	120	150
106	⅔ inch	25	2 0 0	70	112	210	280	350
107	⅔ inch	32	2 10 0					
108	½ inch	45	2 10 0	100	160	300	400	500
109	4/10 inch	65	4 0 0	125	200	375	500	625
110	4/10 inch	95	5 0 0	150	240	450	600	750
111	¼ inch	75	3 10 0	200	320	600	800	1000
112	1/5 inch	120	4 10 0	250	400	750	1000	1250
113	1/8 inch	130	5 0 0	400	640	1200	1600	2000
114	1/10 imm.	180	5 5 0	500	800	1500	2000	2500
115	1/15 imm.	180	8 0 0	750	1200	2250	3000	3750
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152	1 inch	18	1 5 0	46	61	106
153	½ inch	38	1 5 0	90	116	205
154	¼ inch	80	1 5 0	170	220	415
155	1/6 inch	110	2 5 0	250	330	630
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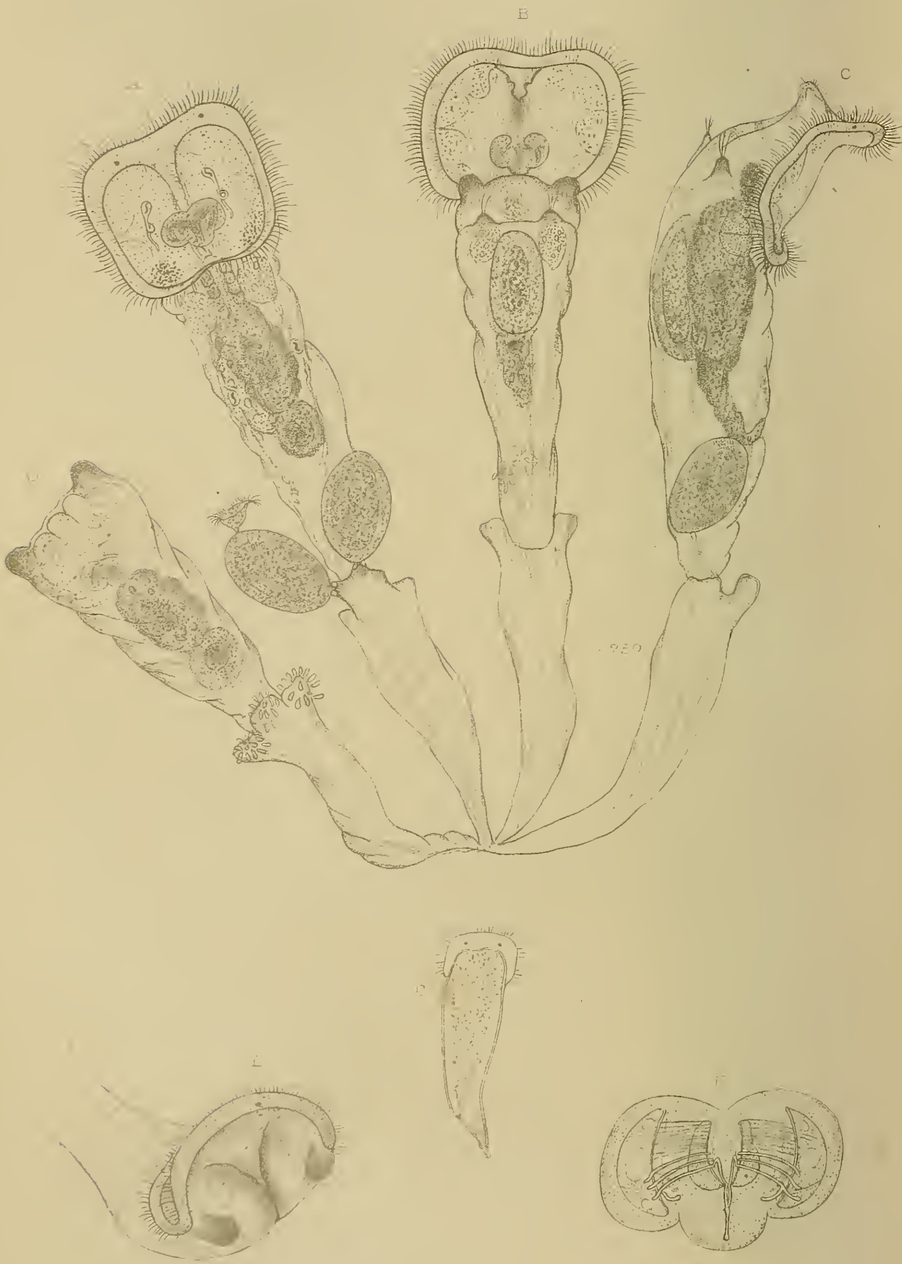


[illegible]rge del. West, Newman lith.

Megalotrocha semibullata

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1889.

TRANSACTIONS OF THE SOCIETY.

IX.—*Description of a New Species of Megalotrocha.*

By Surgeon V. Gunson Thorpe, R.N.

(*Read* 12*th June*, 1889.)

Plate XII.

During the years 1886–9, whilst serving on board H.M.S. 'Paluma,' employed in the survey of the waters between the east coast of Queensland and the Great Australian Barrier Reef, many opportunities were afforded me for the study of microscopic life, both fresh-water and marine. Whilst the higher forms of both the fauna and flora of Queensland are being very thoroughly worked out, this branch of natural history has been almost if not quite untouched. This fact stimulated me to devote my leisure moments to the study of the microscopic life of the colony, and especially to that of the Rotifera.

The localities in which Rotifera are to be found in Queensland are few and far between; water, except at certain times of the year, being scarce in that tropical climate. In May, soon after the rainy season, one occasionally comes across, in the midst of the dense Australian bush, a charmingly secluded little pond, shaded on all sides by Eucalypti, grass-trees, and acacias, with lilies, ferns, and orchids growing in great profusion around; brightly coloured dragon-flies and other insects flitting across its surface; parrakeets and cockatoos screaming overhead. The water of such a pool teems with various species of *Floscularia*, with *Melicerta conifera* and *ringens*, *Limnias annulatus*, *Brachionus militaris*, and many other kinds. Three months afterwards, the same place may be found completely dried up, and the ground fissured in all directions by the fierce heat of the sun; and yet, in the following year, the same locality is as prolific as ever. Again, in marked contrast, at another time one meets with a tiny pool, not more than three or four feet across, on the bleak and rocky headland of an island out at sea, exposed to the storm and to the

EXPLANATION OF PLATE XII.

a, dorsal surface; *b*, ventral surface; *c*, side view; *d*, corona contracted; *e*, view of head from above; *f*, mastax; *g*, male.

glare of a tropical sun, breakers beating on the rocks below within twenty feet of it, with no life to be seen but the eagle soaring overhead, and no sound to be heard but the mournful cry of the dingo as the sun goes down; and yet, strange to relate, I found the water of such a solitary and apparently lifeless pool * literally swarming with the wonderful *Pedalion*.

It was whilst examining the water of a pond in the picturesque gardens of the Acclimatization Society, Brisbane, in February 1887, that I noticed the presence of a number of tiny white globes swimming freely in the water, which I at first took for *Conochilus volvox*. Further examination convinced me that I had found a new species of *Megalotrocha*, an opinion afterwards confirmed by Dr. Hudson, to whom I am indebted for much kind help and encouragement. He proposed the name of *Megalotrocha semibullata*, since it carries but half the number of opaque warts which adorn the body of *M. alboflavicans*, hitherto the only known species of this genus.

The following are the specific characters of this new Rotiferon:—

Sp. Ch.—*Cluster* spherical, free-swimming, consisting of many adults and their young. No coherent gelatinous tubes. *Corona* somewhat quadrilateral, the axes being nearly equal; oblique, and looking towards the dorsal aspect. *Ventral sinus* shallow. *Trunk* with two opaque warts, one on each shoulder, on the ventral surface below the corona, and between it and the ventral antennæ. *Ventral antennæ* below the corona and the opaque warts, as two small setigerous pimples, standing on the arched ventral surface. *Dorsal antennæ* absent. *Eyes* two, bright red, on the upper edge of the dorsal surface of the ciliary wreath, between the inner and outer rows of cilia.

From the above brief description it will be seen that the resemblances to the only known species of this genus, viz. *M. alboflavicans*, are (1) the possession of opaque warts on the ventral surface below the corona; (2) the dorsal position of the gap in the ciliary wreath (gen. ch.); and (3) the absence of gelatinous tubes. The differences are—(1) the possession of eyes in the adult individual; (2) the possession of antennæ; and (3) in the fact that it is free-swimming. These differences will therefore cause some alterations in the generic characters.

The cluster, consisting sometimes of as many as seventy individual is perfectly visible to the naked eye, and is about 1/20 in. in diameter; † each individual being about 1/40 in. when fully grown. Although I examined the leaves of the water-plants very carefully, in no instance was I able to recognize any attachment to the leaf.

The general anatomy of the individual rotiferon resembles in the main points that of *M. alboflavicans*, but a few points require special notice.

* This promontory will be known in future Admiralty charts as Pedalion Point, Dunk Island.

† A mounted specimen under pressure measured 1/12 in. in diameter.

The junction of the pseudopodium, or foot, with the trunk is well marked by a constriction, and presents a peculiar, and I believe unique, structure. The dorsal surface of the upper extremity of the foot is prolonged upwards and outwards, to form a triple expansion, somewhat in the form of a trefoil. The middle portion of this process projects prominently outwards on the dorsal aspect, and to it the eggs are attached, after exclusion from the cloaca. The lateral portions, like buttresses, closely embrace the lower extremity of the trunk, which is wedged in between them.

The *ciliary wreath* is almost quadrilateral, and is placed obliquely looking towards the dorsal aspect. The animal has a habit of doubling the corona on itself, so that a view from above can frequently be obtained of the buccal orifice and the relative position of the two warts to it.

The two *opaque warts* are situated one on each shoulder, on the ventral surface below the corona. Even with a pocket-lens they may be distinctly detected as little black dots scattered over the surface of the white cluster-ball. When the animal contracts, they stand up prominently above the surface of the indrawn head.

Below the warts, on the ventral surface of the trunk, may be seen, by careful focusing, two minute setigerous pimples—the *ventral antennæ*—in position resembling those of *Conochilus dossuarius*, but, unlike them, being distinctly separate, a considerable space intervening.

The *trophi* are orange-tinted, and of the malleo-ramate type. The unci, passing from the mallei to the rami, are three-toothed. The extremity of each tooth attached to the manubrium is bifid, one division being soldered to the upper surface of the manubrium, the other division, curving backwards, lies in contact with its inner side. The fulcrum is very slender, and appears to be double-jointed.

The *œsophagus* is lined with quadrilateral cells, and has salivary glands on either side. The *stomach* is capacious, richly lined with cilia, with large gastric glands in contact with it. The *intestine* takes a short sharp curve upwards towards the dorsal surface, and ends in the cloacal opening at the junction of the upper three-fifths with the lower two-fifths of the trunk.

The *lateral canals* possess two pairs of *vibratile tags*, one pair within the corona, and one on either side of the stomach. A *contractile vesicle* has not been detected.

The *eyes* are two minute bright-red spots on the upper edge of the dorsal surface of the corona, between the inner and outer rows of cilia, but nearer the inner wreath.

There is a large *ovary* between the ventral body-wall and the stomach. The *egg*, after extrusion from the cloaca, becomes attached to the middle portion of the triple expansion of the foot above described. Two ova may often be seen thus attached, side by side, in one or both of which the movements of the unborn rotiferon, with its red eyes, may be distinctly visible. In one instance I saw a young female, newly hatched, still fixed by its hinder extremity to this oviferous expansion, side by side with an unhatched egg. These eggs not infrequently have sessile *Vorticellæ* parasitic upon them.

In December 1888, I was fortunate enough to see the *male* in actual coitus with a female, which had become detached from the general cluster. The two gyrated round each other in circles at a great rate, the male making several ineffectual darts, but finally succeeded in attaching himself in the neighbourhood of the cloaca of the female, who, by the speed with which she swam through the water, appeared to be doing her utmost to shake her paramour off. The male is about 1/200 in. in length, with the characteristic quadrilateral wreath, and two bright red eyes; the hinder extremity is furnished with a short pointed foot. The sperm-sac fills nearly the whole of the trunk.

The cluster is frequently infested with a species of micrococcus, which especially attacks the oviferous expansion and its neighbourhood.

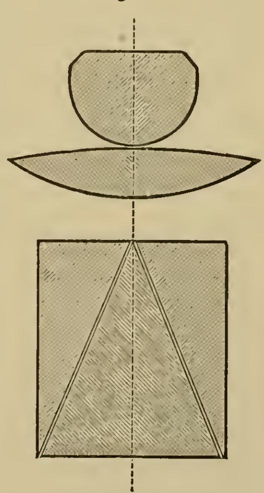
X.—*Note on Polarizing Apparatus for the Microscope.*

By Professor Silvanus P. Thompson, D.Sc.

(*Read* 12*th June*, 1889.)

A few months ago the writer had adapted to his Microscope (a Beck's "Pathological") one of Ahrens's triple polarizing prisms * which he had for some eighteen months been using for other purposes. This prism has an angular aperture of some 28°, far exceeding any ordinary Nicol's prism. The prism is so short, in comparison with its area of cross-section, that it appeared particularly convenient for the purpose of a substage polarizer, provided the line of junction across the end-face of the prism did not interfere with the optical performance. The prism when removed from its mountings is a rectangular parallelopiped, having square end-faces. The side of the square end-face is 17·5 millimetres, and the length of the prism is but 27 millimetres. Mounted below a wide-angled Abbe-Beck condenser, as in fig. 71, with an iris diaphragm between, it gives most satisfactory results. The line of junction across the upper end-face is barely to be detected, and gives no trouble in use.

Fig. 71.



As analyser several prisms have been tried, the most satisfactory being a small prism lately cut for me by Mr. Ahrens, for the express purpose of use over an eye-piece. The following considerations determined its construction. It is obvious that it is of no use to make the eye-end of the analysing prism of greater diametral aperture than that of the pupil of the eye. Any larger aperture than this is not merely wasted, for the prism that has a larger end-face than necessary means a prism that is longer than necessary, and obliges the observer's eye to be further removed from the eye-piece. In Nicol prisms, as ordinarily made, the two end-faces are of equal size, and the lateral faces are parallel. For analysing purposes, however, the prism must have at the end farthest from the eye an aperture greater than that of the pupil, otherwise the eye cannot receive the proper cone of rays. Further, the oblique end-faces habitual in the Nicol prisms of ordinary construction are objectionable, as they waste light by reflection, and take up valuable space. The prism which Mr. Ahrens has cut for me is represented in fig. 72. It is about 11 millimetres long, narrower at the end nearest the eye, and has end-faces square to its axis. These

* Phil. Mag., 1886, p. 476.

end-faces are principal planes of section of the crystal, the optic axis lying in them diagonally. The method of cutting the spar is a simple modification of that adopted of late years by Mr. Ahrens, which, while gaining the maximum angular aperture, causes least waste of spar. Fig. 73 shows another way of attaining the same end by use of a simple divided rectangular parallelopiped of spar, the upper and lower faces

Fig. 72.

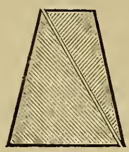


Fig. 73.

of which are, as in the other form, principal planes of section. The cone of useful rays is confined within the dotted lines. The analysers can be used over either an A or B eye-piece.

For showing the rings and brushes in crystal sections with an ordinary Microscope, I have adopted the following arrangement, which is quite as satisfactory as the much more expensive arrangements which go by the name of Nörremberg's apparatus for convergent light. The polarizer described above, together with the wide-angled Abbe-Beck condenser, is fitted in its place in the substage. Ordinary objectives are of little use for the purpose of showing the rings and brushes. What is wanted is a very wide-angled objective of not very high power. Not even the wide-angled apochromatic objectives now in fashion are satisfactory. Instead of any of these, I employ a wide-angled achromatic substage condenser (by Beck), which, being provided with the universal screw, can be removed from the adapter which fits the substage and screwed into the lower end of the tube instead of an objective. The eye-piece must be removed from the draw-tube. To observe the rings and cross of a uniaxal crystal, or the rings and brushes of a biaxal, the crystal slice is placed on the stage, the substage condenser is screwed close up to it from below, and the achromatic condenser in the tube is screwed down close upon it from above. The observer's eye is placed over the open upper end of the tube. Thus viewed, the rings and cross or rings and brushes appear quite small in the contracted field of light. To magnify them, the following very simple device is sufficient. A positive lens of any focal length between $1\frac{1}{2}$ and 4 inches, according to the choice of the observer, is placed about half-way down the tube. A spectacle glass of 3-inch focus, snipped down with a pair of pliers and dropped into the draw-tube so as to rest on the diaphragm, answers very well. The arrangement shows the rings even of those biaxal crystals which have very wide separation between the optic axes, such as gypsum and topaz.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Darwinism.‡—Under this title Mr. A. R. Wallace has published an important and most interesting work in which he gives an exposition of the theory of Natural Selection, with some of its applications. Mr. Wallace, who remains true to his belief in the overwhelming importance of Natural Selection in the production of new species, criticizes very forcibly many recent speculations and theories. While using for his purpose a number of facts already cited, he brings forward a quantity of new evidence, especially on the subject of variations within the limits of a species. He reduces the importance of sexual selection as a factor in producing new species, and he claims for his book the position of being the advocate of pure Darwinism. It is only necessary for us to chronicle the appearance of this important work.

Heredity.§—Mr. J. A. Thomson furnishes a historical summary of theories of heredity, discussing (*a*) those which sought to explain the uniqueness of the germ-cells by special hypotheses such as those involved in "pangenesis"; (*b*) the gradual elaboration of the doctrine of germinal continuity, from Owen and Haeckel to Jaeger and Weismann; (*c*) the auxiliary theories of "organic memory," "perigenesis," chemical continuity, &c., which seek to make the fact of reconstruction more intelligible.

As to the inheritance of acquired characters, the author summarizes the various opinions, emphasizing Weismann's scepticism. The various criticisms of Weismann's conclusions based on concrete cases, on pathological evidence, and on the general theory of evolution are briefly summed up, while the author urges that the general symbiosis of the organism, the common medium of the blood, the frequency of inter-

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

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

‡ 'Darwinism,' 8vo, London, 1889, viii. and 494 pp. (37 figs.).

§ Proc. R. Soc. Edin., 1888–9, pp. 98–116.

cellular connections, the rarity of early insulation of sex-cells, all favour the possibility of environmental and functional variations affecting the reproductive organs, and thus becoming transmissible.

Development of Nail in Human Fœtus.* — M. F. Curtis has investigated the development of the nail in the human fœtus. It follows the law that the lower extremities are always developed more slowly than the upper, and the dates which are here given apply to the nail of the thumb. The formation of the bed of the nail commences in the first week of the third month with the appearance of the first rudiment of the posterior involution; the delimitation of the bed by a peripheral groove is completed towards the middle of the third month. This last is effected by a simple proliferation of epithelium; at this period there is no fibrous band of perichondrial origin which can be considered as in any way the cause of the folding of the epidermis. The area thus delimited in the third month may be called the primitive bed, for it is composed of two segments which are separated by a secondary groove in the first week of the fifth month. The anterior segment alone undergoes the dorsal displacement described by Zander, and becomes later on the region of the angle of the nail, homologous with the sole of the horse. The dorsal segment which alone forms the nail may, from the fifth month, be called the definite bed. The superficial layer which has been called the eponychium really exists; it is a true stratum corneum which, from the beginning of the fourth month, commences to appear at the anterior extremity of the bed. It then grows from before backwards, and at the end of the fourth month covers the whole surface of the bed. The eponychium becomes pushed off from the middle of the bed by the growth of subjacent parts towards the end of the fourth month, and its two extremities alone persist; the posterior of these forms, at this period, the perionyx, while the anterior becomes a persistent thick horny layer at the angle of the nail. In the second week of the fourth month a group of cells is differentiated at the centre of the bed, and in the midst of the mucous body which will give rise to the primitive matrix. This is composed of cells with grains of keratin, but these elements disappear during the ninth month. By the deposit of fresh layers the primitive nail is formed after the rupture of the eponychium; this is characterized by its origin from the keratin-containing cells which disappear later on, by its loose irregular structure, and its constant superficial exfoliation. It is really impossible to say quite exactly when a distinct layer deserving the name of a nail first appears; it is by slow and continuous substitution that the primitive nail displaces and replaces the eponychium. The primitive nail having covered the bed extends from before backwards. While the hinder part of the matrix is displaced, the central part becomes the seat of a new development, for the epithelial cells change in form and become filled with fine granulations of onychogenous substance. The epithelial development of the matrix carries with it the production of new unequal layers, which are distinctly striated, and exhibit no tendency to superficial exfoliation. They constitute the definite nail, and it is, again, by a process of slow and continuous substitution that the definite nail displaces and replaces the primitive nail.

The production of an eponychium, of a primitive and of a definite nail are three connected facts which succeed one another in a regular and constant order.

* Journ. de l'Anat. et de la Physiol., xxv. (1889) pp. 125–86 (2 pls.).

Formation of Placenta of Rabbit.*—We have again an account of the development of the placenta of the Rabbit, M. J. Masius now being the author. Previously to the formation of the blastocyst the mucous membrane of the uterus becomes very thick, and forms on its surface large papillæ; these, which are separated from one another by narrow crypts, form a large projection on which the epiblast is fixed and the placenta developed. Neither the glands nor the epithelium of the uterus take any part in the formation of the placenta. The vessels of the mucous membrane become surrounded by a sheath of cells which are all derived from the fixed cells of the dermis; these sheaths are developed by the mitosic division of the cells which constitute them, acquire a large size, and form the dominant mass of the dermis in the advanced stages of the formation of the placenta. The endothelium of the vessels of the mucous membrane degenerates and disappears; when it disappears the perivascular sheath directly bounds the cavity of the vessel and the blood may filter in small quantities through the perivascular cells.

In the early stages the mucous membrane contains a large number of elements which the author regards as leucocytes; these become converted into corpuscles formed of a moniliform chromatic cord or of chromatic granulations. These cells are scattered in the dermis of the mucous membrane and in certain vessels, but the author does not yet know what their function is.

Just before the fixation of the blastocyst to the mucous membrane two layers may be distinguished in the embryonic epiblast; the deeper one has cylindrical cells, the outer has nuclei arranged in nuclear nests and there is no division into cellular areas. It is by means of this superficial layer that union is made with the uterine mucous membrane; the layer soon becomes enormously developed and forms a multinucleated protoplasmic mass into which the deeper epiblastic layer sends primordial papillæ, at first non-vascular and formed of epiblast and somatopleure. On the other hand, the capillaries of the mother become engaged in this multinucleated protoplasm of fœtal origin, where they lose their endothelium, and become continuous with a system of numerous lacunæ without proper walls.

The allantois, by fusing with the serosa of Von Baer, vascularizes the primordial papillæ by forming in them a connective axis rich in blood-vessels. But, as this fusion is effected, the deep layer of the epiblast becomes interrupted around this connective axis of allantoidean villosities. As a result of this, the maternal blood of the placenta circulating in large lacunar spaces is, in many places, separated from the connective vascular villosity by nothing more than a more or less thick layer of multinucleated epiblastic protoplasm.

The author regards the placenta of the Rabbit as a new formation of fœtal origin formed by allantoic villosities branching in a tissue which arises solely from the epiblast of the embryo. This new formation becomes fused with the dermis of the mucous membrane, the vessels of which form quite a system of lacunæ without proper walls, which traverse a multinucleated protoplasmic mass not broken up into cell-areas, and owing its origin to a very great increase in thickness of the superficial layer of the epiblast. In the placenta the maternal blood circulates in an epiblastic mass of embryonic origin.

* Arch. de Biologie, ix. (1889) pp. 83–121 (4 pls.).

In the course of the development of the placenta the cavities of the crypts lined by much altered uterine epithelium may be filled with maternal blood; this is due to the presence in the crypts of holes with no proper walls, which traverse the epiblastic mass in such a way as to establish communications between the lacunar blood-system of the placenta and the epithelial crypts. This arrangement allows of the presence of the maternal blood between the epiblast and the surface of the mucous membrane of the uterus.

Structure of Graafian Follicle in Didelphys.*—Mr. F. E. Beddard gives an account of the Graafian follicle in the Opossum, which agrees more closely with that of *Phascolarctos* than with that of *Phalangista;* that of the last-named Marsupial seems to the author to nearly represent the hypothetical intermediate condition between the Monotremata and the higher Mammalia.

Early Development of Lepidosteus osseus.†—Dr. J. Beard gives an outline of the development of *Lepidosteus* during the first three weeks of its life. The investigation of that of the first four days is very difficult; for the yolk outside the embryo gives rises to technical difficulties, while that which fills all the cells renders everything blurred and indistinct. As to the egg the author has little to add to the description given by Balfour and Parker. The blastopore closes on the second day, and at no time is there a neurenteric canal; the mesoderm arises very early and before the closure of the blastopore. The epiblast is very early divided into two layers, the outer of which takes no share in the formation of organs, and may be, perhaps, compared to the skin of a larval Annelid; the inner layer may be spoken of as the formative epiblast. In the central nervous system the transient giant ganglion-cells may be distinguished from the ciliated groove which forms the floor of the primitive central canal. The roof of the fore-brain is very thin both in embryo and adult; it is non-nervous and epithelial in character, as in Marsipobranchs, Teleostei, and other Ganoids. Behind the anus the spinal cord is for some time solid.

The larval suckers are developed very early, in the form of a number of closed spherical sacs, a part of the wall of which is thin and soon ruptured. The functional suckers are composed of two sorts of cells—long, glandular cells with hyaline, slightly granular contents and a nucleus lying near the inner end of the cell, and supporting cells with the nucleus in the middle of the cell.

The first branchial cleft is formed long before the others and before hatching; the pneumatocœle arises at a very early period and long before hatching; it is a fold of the neural median hypoblast and grows backward in length, apart from connection with the alimentary canal. The somites, which are at first solid, are long and narrow; the inner wall of the somites gives rise to muscle, and most of the outer wall is converted into pigmented connective tissue. The pronephros is formed as a solid evagination of the mesoblast; it probably fuses with the epiblast; at any rate a solid segmental duct is formed, probably from the inner epiblast layer. Three funnels seem, as a rule, to be formed on each side of the body, but the most posterior of them disappear, the others persisting throughout the larval period.

In conclusion, the author calls attention to a transient and larval

* Proc. R. Phys. Soc. Edinb., ix. (1888) pp. 407–12.
† Proc. Roy. Soc. Lond., xlvi. (1889) pp. 108–118.

nervous apparatus in *Lepidosteus* and certain other Ichthyopsida. The presence of the giant ganglion-cells in the embryo has already been referred to; in all the cases examined they occupy the same typical position in the extreme dorsal or neural border of the spinal cord. When a series of horizontal longitudinal sections are made these cells are found to form a double row which reaches from the termination of the hind-brain to the posterior limit of the central nervous system. They are the first cells in the embryo which develope ganglionic characters and they are fully developed in young embryos long before the remaining cells of the nervous system become ganglionic. The cells, which are multipolar, are arranged bilaterally, and there must be several hundreds of them. They become all shut out of the central nervous system; these processes are either withdrawn or cut off, and their poles present a curious stumpy appearance. The cells persist for a long time, lying outside the cord, just over the posterior fissure. They finally undergo a series of changes corresponding exactly to that degeneration and death of nerve-cells which pathologists term simple atrophy. It is very significant to notice that the forms in which they normally occur are, without exception, oviparous. The author thinks that Kleinenberg was quite right in his suspicion that the giant cells described by Mayer might be analogous to certain subumbrellar ganglion-cells in the larva of *Lopadorhynchus*, which "introduce" the development of the ventral cord; just as in that Annelid, the development of the vertebrate central nervous system would appear to have been initiated by a larval nervous apparatus outside the same.

Spermatogenesis in Mammals.*—Herr G. Niessing finds that the general results of his investigations into the spermatogenesis of Mammals may be thus summed up. The seminal canaliculi of sexually mature Mammals contain only one kind of cell, and these give rise to the spermatozoa. The cells are arranged in families which consist in the resting-stage of three generations, and are disposed in columns. The oldest member of a family is the stem-cell, on which follow centripetally the mother and daughter-cells. When the testis passes into the active stage there is first an alteration in the form of the daughter-cells. Their nucleus passes to the peripheral cell-wall. All the chromatin becomes collected in the anterior half in such a way that it is thickest in the equatorial plane which divides the two halves. The nucleus begins to be constricted behind the equatorial plane, the anterior part gradually taking on the form of the head of the spermatozoon, while the part devoid of chromatin becomes colourless and presents in its interior the filament; this traverses the nuclear membrane and becomes longer and longer. The altered nucleus generally becomes separated in this form from the cell-body; the cylinder narrows continually around the later median-piece and produces the spiral filament of this median piece, which appears shortly before maturation. The tail which, by the aid of suitable reagents, may be shown to consist in its anterior part of a number of very fine fibrils, arises from the nucleus only. The whole of the spermatozoon is consequently formed from the nucleus only.

After the metamorphosis of the daughter-cells spermatogenesis commences in the mother-cells and then in the growing mother-cells. Spermatogenesis is effected, therefore, in three stages, and the stem-cells

* Verhandl. Phys. Med. Gesell. zu Würzburg, xxii. (1889) pp. 35–63 (2 pls.).

as such take no part in it. The spermatozoa of the second and third stages remain as bundles in the protoplasmic mass arising from the altered cells, and lie among the neighbouring families; with the empty, folded mother-cell-membrane they form the spermatoblasts of v. Ebner. The spermatozoa are pushed out by the extension of the neighbouring cell. After the spermatozoa of the third stage are completed, the cell-families become regenerated from the stem-cells.

Embryonic Cell-division.*—The most important results of Herr E. Schwarz's investigations into cell-division in the embryo are:—(1) The nucleus of cleavage-cells is a radial, uniaxial, "heteropolar" structure. (2) The poles of division are separately laid down; the axis of division is perpendicular to the nuclear axis; the planes of division are symmetrical, and the succeeding planes of division, as well as the axes, are perpendicular to one another. (3) The chromatin-structures are well-developed loops, the number of which may be twenty-four. (4) The nuclear spindle consists of two kinds of achromatic bundles of fibres, both of which arise from the nucleus, and both parts pass into daughter-nuclei. (5) The chromatic daughter-loops each form nuclear elements with the achromatin which belongs to them, and by their union the daughter-nuclei are formed. (6) Direct division does not obtain either in the cellular or in the plasmodial portion of the germinal disc.

β. Histology.†

Structure of Nerve-fibres.‡—Prof. F. Leydig thinks it opportune to direct attention to some of the conclusions to which he has been led with regard to the structure of nerve-fibres. He has already given reasons for believing that the nerve-fibres of Annelids and Arthropods are better called tubes, and that they consist of a spongioplasm enveloping a hyaloplasm, the latter being the true nervous material, and the former a supporting network.

Among Vertebrates the non-medullated trunks of the olfactory nerve have been examined in the Salamander and the Cat, and it has been found that the "fibrils" are parts of a hollow system which is traversed by a fine network. The author has pointed out that the more essential constituent of a nerve—the material found in the ducts, which is probably of a semifluid nature—has been left out of consideration. Medullated nerves have been chiefly examined in *Hyla* and *Rana;* when cross-sections of these, preserved in chromic acid, were examined, the nerve-fibres were seen to be tubes filled with a clear substance; this last is traversed by lines of network which call to mind what have been seen in the nerve-tubes of Invertebrates. The recent work of Joseph, who has made more extensive observations on Vertebrates, substantiates the conclusions of Prof. Leydig. Retzius, also, in essential points supports Leydig.

The recognition of the fact that in the minute structure of ganglionic spheres and of nerve-fibres we have to distinguish a supporting substance (spongioplasm) from an inclosed homogeneous material (hyaloplasm or true nervous substance) is closely connected with the results which the author has obtained with regard to muscular tissue. There, too, we

* MT. Embryol. Inst. K. K. Univ. Wien, 1888 (1889) pp. 30–73 (2 pls.).
† This section is limited to papers relating to Cells and Fibres.
‡ Biol. Centralbl., ix. (1889) pp. 199–204.

have a framework which is firmer than the inclosed homogeneous fluid material which is regarded as the true contractile substance.

Peripheral Nervous System of Amphioxus.*—Dr. R. Fusari has used in the study of the peripheral nerves of *Amphioxus* the chloride of gold and potassium method recommended by Golgi; he has been able to demonstrate the presence of a sympathetic nervous plexus and of branchial nerves. A branch of the dorsal spinal nerves divides, when it reaches the peritoneum, into two branches; one branch, the sympathetic, is distributed to the peritoneum itself; the other passes upwards and comes into relation with the branchiæ.

By a careful study of the details of the cutaneous nerves the author has been able to find the cause of the divergences of opinion which have been expressed regarding them. The arrangement differs in different regions; on the skin of the back and the lateral regions it is quite exceptional to find anastomoses between two nerve-trunks, while on the skin of the abdomen they are so numerous that we may almost say that this region forms a true plexus. In the latter, also, there are ganglionic cells in the nodal points, and there are small ganglia formed of two nerve-cells. The final ramifications of the cutaneous nerves are very delicate fibrils, which, in chloride of gold preparations, appear to end freely. In very fine sections some filaments may be seen to traverse the cuticle which supports the epidermal cells. The author agrees with Langerhans in believing that there is a direct connection between the nerve-endings and the epithelial cells.

The branchial nerves may be seen to ramify on the external membrane which invests the branchial apparatus; the plexus thus formed is very delicate at some points, and has a general resemblance to those which are often found among the pseudopodia of *Amœbæ*. Two types of ramification are distinguished in the sympathetic branches.

With regard to the first two pairs of nerves which have by some authors been regarded as comparable to the fifth pair of cranial nerves in other vertebrates, in consequence of their possession of what have been considered to be ganglia, the author states that these bodies are formed of one to four cells, from which one, two, or even three nerve-fibres are given off; they may consequently be regarded, in correspondence with the views of several anatomists, as peripheral ganglia.

Role of the Accessory Nuclear Body in Secretion.†—Herr G. Platner has investigated the histology of secretion in the pancreas of chelonians, lizards, snakes, and amphibians, comparing the phenomena there observed with those seen in the Malpighian tubes of insects. Accessory nuclear bodies (Nebenkerne) are constant in the pancreas of reptiles and amphibians and in the above-mentioned tubules. With the appearance of secretion-globules in the protoplasm, a remarkable nuclear activity is associated. By a process of nuclear budding, not to be confused with division, an accessory body is formed, which seems to be an eliminated surplus of nuclear material, and to have a genuine secretory significance. In the secreting cells there may be only one accessory body or several; according to their age these exhibit more or less trace of nuclear characteristics; finally they undergo retrogressive metamorphoses and disappear.

* Arch. Ital. Biol., xi. (1889) pp. 237–42.
† Arch. Mikr. Anat., xxxiii. (1889) pp. 180–92 (1 pl.).

γ. General.

Zoology of Afghan Delimitation Commission.* — Dr. J. E. T. Aitchison has issued the reports by various specialists on the animals collected by him when attached to the Commission. 290 species belonging to 210 genera, of which 32 species are new, were collected.

Mollusca.

Anatomy and Life-history of Australian Mollusca.†—The Rev. J. E. Tenison-Woods has made a study of the Mollusca peculiar to Australia. He considers that, though not separated in an extraordinary way from Molluscan provinces elsewhere, Australia is entitled to be considered a true Molluscan province, with peculiar features; these characters are more strongly manifested in proportion as the coast-line is followed to the south: the tropical fauna of the Indian Ocean is extended in many respects far into the extra-tropical portions of the Australian seas. The sense-organs in the tegmentum of the shell, which were first discovered by Prof. Moseley in several genera of Chitonidæ, are found in many genera of both bivalves and univalves, such as *Trigonia*, *Arca*, *Venus*, *Ostrea*, *Patella*, *Cerithium*, *Turbo*, &c. In two species of *Trigonia* the development of the eyes strongly resembles that of the ommatidia of Insects, with which the sense-organs are associated. In connection with these are large ganglia and dependent nerves which are found in the substance of the shell of both bivalves and univalves. The calcareous opercula of some species contain nerve-ganglia and sense-organs, as do probably the chitinous opercula also, to a small extent. The ganglia in the shell-substance are so much larger than any nervous tissue in the softer parts of the animal, that they are apparently the main sources of nervous influence; these ganglia suggest from their position and the multiplicity of sense-organs that they are really cerebral ganglia. The bivalves examined will, if this is so, be seen to have been erroneously described as acephalous; they are, if anything, better endowed with a head and brain structure than some univalves. In the mantles of both bivalves and univalves eyes have been found, as well as on the dorsal papillæ of some species of *Onchidium*.

In following the life-history of young oysters it was found that the ova are nursed in the gill-chambers of their parent, a fact which may have an important influence upon their cultivation. A similar arrangement has been found to exist among certain species of *Unio*, *Siphonaria*, *Patella*, and *Acmæa*. In very young *Siphonaria* the lobe of the mantle in front of the head was found to be covered with from 80 to 90 minute spherical and highly refractive bodies which seem to be sense-organs and may have visual powers.

If all the new facts described in this remarkable paper should be shown to be exactly reported, there will be no doubt that the author deserves the prize awarded for it by the Royal Society of New South Wales.

Eyes of Mollusca.‡—Herr J. Carrière has a review of the recent works of Patten and Rawitz on this subject; as to the former he uses some very hard words, and since the memoir is in many points one in which statements are directly traversed, we will content ourselves with calling attention to it here.

* Trans. Linn. Soc. Lond., v. (1889) pp. 53-142 (9 pls. and 2 maps).
† Journ. and Proc. Roy. Soc. N. S. Wales, xxii. (1888) pp. 106-87 (12 pls.).
‡ Arch. f. Mikr. Anat., xxxiii. (1889) pp. 378-402 (1 pl.).

β. Gastropoda.

Secretion of Sulphuric Acid by Marine Gastropods.*—Dr. R. Semon has experimented on the chemical and mechanical characters which protect many animals against the hunger of their neighbours, and has directed his attention especially to the abundant presence of spicules. In this connection he was led to observe how various "specialist" gastropods, e. g. *Dolium galea*, *Tritonium nodiferum*, and *Aplysia*, devoured Echinoderms in spite of their calcareous deposits. Now these and many other marine gastropods have for long been known to exude a fluid rich in free sulphuric acid. The possible uses of this secretion are discussed, and the author concludes from his observations that it plays a preliminary part in digestion, changing the carbonate in the favourite food into readily pulverized sulphate of lime, and thereby removing the obstacles in the way of such diet.

Purple of Purpura lapillus.†—M. A. Letellier finds that the purple-forming band in *Purpura lapillus* is made up of a secreting epithelium formed of ciliated cells, some of which are alone purpurigenous, while most merely produce mucus. The purple material is produced by three substances, one of which is yellow and non-photogenic, while the two others become blue and carmine-red under the influence of the rays of the sun. After giving a careful chemical and crystallographic account, the author expresses his opinion that the purple is produced by a true chemical reduction. The function of this body, which is most abundant during the breeding season, is comparable to the castoreum of *Castor*, as it seems to bring about the congress of individuals for the purposes of reproduction.

Nudibranchiata of Liverpool District.‡—Prof. W. A. Herdman and Mr. J. A. Clubb have a second report on the Nudibranchiata of the Liverpool Marine District. *Dendronotus arborescens* was found to vary considerably in abundance at different periods of the year. The authors have carefully studied its anatomy, and are able to add to or correct the statements of Alder and Hancock and of Bergh. They did not find any trace of prolongations from the liver extending actually into the rhinophores and the dorsal papillæ; the correction of the error is due to the use of thin serial sections. In the sections of the cerata themselves they find large spaces in the mesoderm containing blood-corpuscles; these run, in the main, longitudinally; they occasionally branch, and they open into innumerable minute lacunæ in the mesodermal tissues, all of which here and there contain blood-corpuscles. There is a good deal of pigmented connective tissue and ramifying threads of a brownish colour; these frequently give rise, in a surface view, to the appearance of a dark-coloured granular central cæcum, such as that figured by Bergh. There are also to be seen masses of large distinctly nucleated cells lying in meshes of fibrous connective tissue; these are possibly mucus-secreting glands, and occur chiefly in the smaller branches of the cerata.

The upper end of each dorsal papilla of *Eolis* is occupied by a sac containing a large number of thread-cells; this sac is evidently an invagination of the ectoderm, and it communicates with the exterior by a small but perfectly distinct and clearly bounded aperture at its apex,

* Biol. Centralbl., ix. (1889) pp. 80–93.
† Comptes Rendus, cix. (1889) pp. 82–5.
‡ Proc. Biol. Soc. Liverpool, iii. (1889) pp. 225–36 (1 pl.).

through which the thread-cells are sometimes found protruding. The hepatic cœcum occupying the greater part of the dorsal papilla reaches nearly to the lower end of the sac containing the thread-cells, and in several of these sections the authors saw a tube with muscular walls leading from the base of the cnidophorous sac and opening into the apex of the hepatic cæcum by a small terminal aperture; this last is surrounded by a distinct sphincter muscle, so as to allow the lumen of the hepatic cæcum to communicate with the cavity in which the thread-cells lie, and therefore with the exterior when the sphincter is relaxed.

Anatomy and Development of Renal Apparatus of Pulmonate Gastropods.*—Herr T. Behme finds that there are some terrestrial pulmonate Gastropods which have no secondary ureter to their kidney; such are *Helix pulchella*, *Buliminus pupa*, and others. The kidney, however, agrees so closely with that of a *Limnæa* that we may assume the great probability of their developmental history being similar. On the other hand this history strengthens the view of von Ihering as to the origin of the secondary ureter in his so-called Nephropneusta. The kidney at any early stage of embryonic life opens with the primordial kidney directly to the exterior; later on it opens by a primary ureter at the base of the lung-cavity into an open groove which passes to the respiratory cleft; this groove is formed by the walls of the pulmonary chamber. The primary ureter becomes converted into the secondary kidney, and, as the groove in the lung-cavity gradually becomes closed from behind forwards, the ureteric apparatus is completely formed. *Helix pomatia* which, so far as its ureteric apparatus is concerned, agrees with the most highly organized Pulmonata, also exhibits during development all the lower stages in the development of the excretory apparatus; these lower stages are retained throughout life in various other species. We are, consequently, led to conclude that, so far as the renal apparatus is concerned, the families and species with incompletely developed secondary ureters remain at a lower grade; the lowest is seen in those forms whose kidneys are emptied by means of a primary ureter.

The value of these characters from a systematic point of view can only be tested when the comparative anatomy of other organs has been made out.

Reproductive Organs of Aplysiæ.†—Sig. G. F. Mazzarelli describes the anatomy of the reproductive organs in the *Aplysiæ* of the Gulf of Naples. The hermaphrodite gland, large but compact; the "small hermaphrodite duct" varying in its details in different species; the albumen gland and the associated complex nidamental organ; the "large hermaphrodite duct" (vagina of Delle Chiaje, uterus of Meckel) are described at length. The spermatic bursa is independent of the vagina, and is in communication on one hand with the seminal vesicle by means of the vas deferens, and on the other hand with the penis by the spermatic duct. It is simply a second seminal vesicle. The spermatic duct and the penis are then described at length. The complex relations of the different parts are illustrated in a diagrammatic figure.

* Arch. f. Naturgesch., lv. (1889) pp. 1–28 (2 pls.).
† Zool. Anzeiger, xii. (1889) pp. 330–7 (1 fig.).

Molluscoida.

α. Tunicata.

Alternation of Generations in Salpæ.*—Dr. O. Seeliger discusses the problem of the origin of alternation of generations in *Salpæ*. He reviews the various statements and interpretations of the facts, especially those of Todaro, Brooks, Salensky, and Ulianin, but is dissatisfied with all. The alternation has arisen from an original "hypogenetic" process in the following way. A portion of the hermaphrodite system became degraded and gave off buds, with which processes of the parent ectoderm and endoderm co-operated. The remaining portion of the reproductive organ in the parent organism retained its normal function. In *Pyrosoma*, the forms produced by budding retained both modes of multiplication.

At a further stage, not a portion merely, but the whole reproductive organ of the original solitary form was used up in budding. An asexual generation thus arose, as at present exhibited in *Salpæ*. At the same time, with increasing dimorphism of generations, the asexually produced individuals lost the power of budding.

In *Pyrosoma*, the *stolo prolifer* forms only about six individuals, each of which has in the ovarian strand one large ovum and a considerable number of undifferentiated reproductive cells. In *Salpa*, on the other hand, the *stolo prolifer* of the solitary form gives off many hundred closely apposed buds, in which only a few cells are found in the ovarian strand able without special delay to form the hermaphrodite system. In the chain *Salpa* there are no further cells, as there are in *Pyrosoma*, in a position to become the mesoderm of fresh buds. Furthermore, in the close disposition of the *Salpa* buds, there is neither space nor nutrition for another generation of buds, even if ectoderm and endoderm should still retain the embryonic character which would admit of their taking part in a budding process.

β. Bryozoa.

Polyzoa of the Voyage of H.M.S. 'Challenger.'†—Mr. A. W. Waters has prepared a short supplementary report on the Polyzoa, in which he adds particulars of various structures and organs not previously noticed. The most interesting discovery appears to be that of the presence of a common parenchym cord surrounding the zoœcia of *Retepora columnifera*. Mr. Waters thinks that we must not be satisfied merely with the shape of the operculum, but we must give special attention to the way in which it is attached and articulated, and the connection through the rosette plates must be more studied. Too much attention seems to be attached to peristomial characters.

Bryozoa of New South Wales.‡—Mr. A. W. Waters describes a number of incrusting species of Bryozoa obtained off Green Point, Port Jackson. Some of these are new, and others, being represented by better specimens than heretofore, are now more fully described.

Reproduction of Ctenostomatous Bryozoa.§—M. H. Prouho gives an account of some observations on the reproduction of *Alcyonidium*

* Jenaische Zeitschr. f. Naturwiss., xxii. (1889) pp. 399–414.
† Reports of the Voyage of H.M.S. 'Challenger,' xxxi. pt. lxxix. (1889) 41 pp. (3 pls.).
‡ Ann. and Mag. Nat. Hist., iv. (1889) pp. 1–24 (3 pls.).
§ Comptes Rendus, cix. (1889) pp. 197–8.

albidum, *A. duplex* (sp. n.), and *Pherusa tubulosa*. The ova of the first of these escape into the perivisceral cavity, whence they are severally projected to the exterior by the so-called intertentacular organ, the function of which has been so much discussed. In *A. duplex* the phenomena are more complicated and more interesting. When the sexual elements are about to be developed, the zoœcium is occupied by a polypide, without any intertentacular organ, and a cellular mass, which is destined to form the spermatozoa, appears by the wall of the gastric cæcum. Towards the aboral extremity of the same zoœcium there is formed a second polypide, on the funiculus of which young ova appear. The older polypide appears to be the male, the younger the female. The former soon begins to degenerate, and leaves the brown body and the mass of spermatozoa; the female polypide is now seen to be provided with an intertentacular organ, which conveys the ova to an invaginated sheath, where development is effected as in a marsupium. *Pherusa*, like *Membranipora* and *Flustrella*, has a bivalved larva.

Arthropoda.

Ancestors of Myriopods and Insects.*—Prof. B. Grassi has an elaborate essay on the comparative anatomy of the Thysanura, together with some general considerations on the organization of Insects. The external skeleton and the segments are first dealt with; there are three thoracic segments, and ten abdominal; those authors are incorrect who regard the anal valves as representing a segment; like the Thysanura, the embryos of higher insects, e. g. the bee, have ten abdominal segments. The author does not think that the epicranial suture is of any assistance in determining the number of cephalic segments.

The disposition of the muscles does not afford any support to the view that the Thysanura have lost wings which they once had; on the other hand, we may say that just as they are provided with lateral prolongations which might well be developed into wings or gills, so are they in the same way provided with muscles which would enter into the service of such organs. Although the musculature of these low insects is divided into dorsal and ventral portions and into lateral areas it has no intimate relations with that of *Peripatus*.

The respiratory system is treated of in the third section. The most primitive arrangement seems to be found in *Japyx solifugus*, where there are eleven pairs of stigmata, four thoracic, and seven abdominal. *Campodea* has only three pairs of thoracic stigmata, the third, as well as the last seven of *Japyx solifugus*, being wanting. In *J. Isabellæ* there are two thoracic and seven abdominal pairs, and the same is the case with *Machilis*. The Lepismidæ have probably three thoracic and seven abdominal. The fact that *J. solifugus* has four pairs of thoracic stigmata points to the conclusion that the original position of the thoracic stigmata was not segmental. The conditions found in the Lepismidæ are retained by the Blattidæ, and by the Orthoptera generally, and they are also reproduced in the embryo of the Bee. The author's observations tend to modify considerably the fundamental conclusions of Palmén—for example, we must accept Gerstaecker's view that a large number of Insects have still three pairs of stigmata and not two; there is a direct passage between the conditions which obtain in the Thysanura and in

* Atti R. Accad. Lincei.—Mem., iv. (1887) pp. 543-606 (5 pls.). Arch. Ital. Biol., xi. (1889) pp. 1-11, 291-337, 389-419 (5 pls.).

the Orthoptera; as to the latter point, much supporting evidence is afforded by the tracheæ. The same is true of the bee, for the embryo passes through a stage which recalls that of *Machilis* and *Campodea*, and then becomes very like that of the Lepismidæ. The author considers that the formation of the apodemes must have been cotemporaneous with that of tracheæ, for both start as infoldings of the hypodermis. When this infolding is filled entirely, or almost entirely, with cuticle (chitin) secreted by the invaginated hypodermis, we have an apodeme, but when the cuticle only invests its free surface, we have a small canal lined with cuticle, that is to say, a trachea with its stigma. Further, there must be a very close connection between the formation of apodemes and of the tracheal system from the physiological point of view, for the thickening of the cuticle requires the formation of new respiratory organs; the thickening of the cuticle allows the musculature to develope itself more largely, and the musculature, in its turn, tends to produce depressions of the hypodermis, and of the cuticle to which it may become attached; it tends, in fact, to give rise to apodemes.

The nervous system and sensory organs are next discussed; this system and the eye of the Thysanura are of the same type as those of other insects, but are comparatively more simple. The nervous system of *Campodea* is still closely connected with the hypodermis, and at certain points (where the ganglia attain their maximum size) it is altogether connected with it, there being no dividing gangliolemma; in *Japyx* and others this gangliolemma consists of a simple layer of flattened cells, and in *Japyx* there is a comparatively large lacuna between the gangliolemma and each ganglion.

The intestine becomes more complicated as we pass from *Campodea* to *Lepisma*, the latter resembling the true Orthoptera by its well-developed gizzard, the curves of the median and posterior intestine, the diverticula of the rectum and the salivary apparatus. Prof. Grassi believes that the Malpighian tubules are homodynamous with the stigmata and corresponding tracheæ.

The dorsal vessel is exactly like that of other Insects; no alar muscles were discovered in any of the Thysanura, though they are known to exist in the Collembola. In several, and particularly in *Machilis*, there are occasional traces of a vessel uniting the dorsal vessel with the intestine. Anatomical and embryological facts seem to establish the homology of the dorsal vessel of Insects with that of Annelids.

The Thysanura have, as a rule, an oviduct (uterus), a vagina, and a bursa copulatrix. The first is absent in *Campodea* only; *Machilis* has no bursa and appears to be simpler than its allies. The arrangement which obtains seem to support the views of Palmén as to the double nature of the genital ducts.

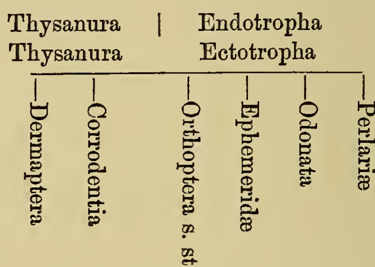
After a somewhat detailed account of the generative apparatus the author concludes that in the ancestors of Arthropods the sexual products were, as in certain Annelids, eliminated by means of the segmental organs; later on one of the two pairs was closed; in the secondary sexual organ of *Campodea* there exist signs of the closed pair.

The appendages, especially the gnathites, are discussed at some length; all the Thysanura have a galea (external lobe of maxilla); this is a character which is repeated only by the Orthoptera and some Neuroptera, and is not found in any other insect.

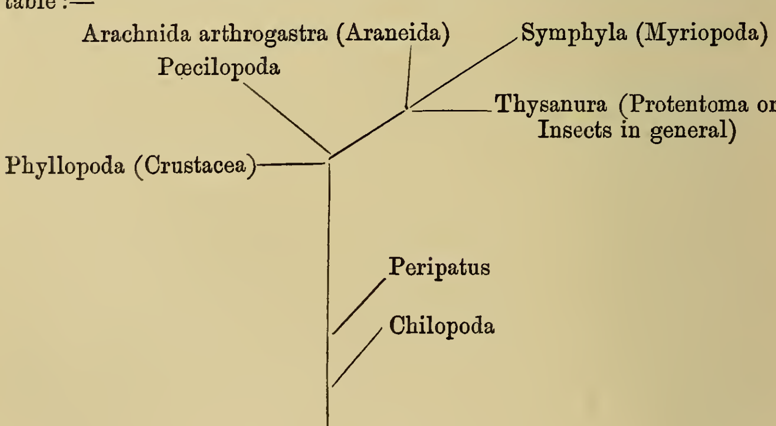
Passing to systematic problems Prof. Grassi asks if the order of the Thysanura is a natural one. He thinks it is, and he places it under the "superordo Orthoptera s. lat.," and divides it into two suborders; the simpler, or that of the Entotrophi, contains the two families Campodeadæ and Japygidæ, and the Ectotrophi, the Machilidæ and Lepismidæ. In the former the buccal apparatus is partly retained within the head and partly fused into a lower lip; in the latter there are external gnathites and the lower lip is deeply divided.

The Entotrophi may have eleven, the Ectotrophi never have more than ten stigmata; in the former the Malpighian tubes are rudimentary, while they are well developed in the latter. These and other characters which are duly enunciated justify the division into these two suborders.

The next question discussed is what relations have the Thysanura with the different orders of insects proposed by Brauer and with the Collembola. The author regards the Thysanura as the lowest order of Orthoptera (*sens. lat.*), and the other Orthoptera as being derived from Insects allied to them.



The superorder of Orthoptera might be called the Protentoma and all other Insects the Metentoma. The author regards as the most important result of his researches the full justification of the hypothesis that the Thysanura are the most primitive Insects that we know, at least in the greater number of their organs. Further researches on the Collembola will probably lead to their being placed with the entotrophic Thysanura. Prof. Grassi's views as to the relationship which obtains between the various groups of the Arthropoda are shown in the following table:—



a. Insecta.

Insects supposed to be distasteful to Birds.*—Mr. A. G. Butler, who keeps a large number of birds, has observed that no insect in any stage was ever refused by all the birds; what one bird refused, another would eat. He is of opinion that metallic colours are not a source of protection to birds; a bird knows nothing of the nature of metal, but whatever is brilliant and shining he makes for at once to see whether it is good to eat. It appears to him that certain species of Lepidoptera and of other insects may become abundant in certain years owing to the temporary scarcity of their particular enemies, but they never enjoy perfect immunity from destruction. The spider-like appearance of the larva of *Stauropus* is not a protection against birds, for, if there is anything that all insectivorous birds love it is a spider. The sting-like tentacles of the larva of *Dicranura vinula* are likewise no protection; three young nightingales never hesitated for a moment to use the tentacles as handles to assist them in knocking the life out of the caterpillar before devouring it.

Histology of Insects.†—Dr. C. Schäffer first treats of the ventral glands in the larvæ of Lepidoptera. As seen in *Hyponomeuta evonymella* the ventral gland is a tube which commences in the metathorax, which is continued forward to the anterior edge of the prothorax where it opens on a conical projection which is provided with two retractors. It is surrounded by a rich system of tracheæ arising from several large trunks. It is distinctly divisible into an anterior and a posterior portion. A similar organ is found in *Harpyia* and in *Plusia gamma*, and it may, therefore, be reasonably supposed to be widely distributed among the Lepidoptera. It appears to be derived from a simple invagination of the hypodermis.

The second subject dealt with is the site of blood-formation in the larvæ of Insects; in *Hyponomeuta evonymella* the blood is found in the fat-body (in its widest sense) and in the matrix of the tracheæ.

In *Smerinthus*, *Ocneria*, *Gastropacha*, *Pieris*, *Vanessa*, and *Harpyia*, the cells which form the blood-forming tissue are differentiated during the embryonic development of the fat-body. In *Lyda erythrocephala* the site of origin of the blood is widely distributed through the body; while in *Hyponomeuta* the tissue is only found at the rudiments of the wings, it has in *Lyda* the form of cell-aggregates which are scattered through the whole thorax and abdomen of the caterpillar, though always in more or less close connection with the fat-body. In the larvæ of *Musca* the fat-body is chiefly formed from the tracheal matrix, while the hypodermis gives rise both to blood-corpuscles and to cells of the fat-body; the latter possibly give rise to the fat-body of the adult.

The chief point brought out by the author is the genetic connection between the fat-body and the blood corpuscles in the first place, and then of the ectoderm (hypodermis and tracheal matrix) on the other side, and the fat-body and blood corpuscles on the other. The last may, in the nomenclature of v. Wielowiejski, be called the blood-tissue. The chief function of the fat-body is to take up and give out again nutrient substances, so that the proposed name is physiologically as well as morpho-

* Ann. and Mag. Nat. Hist., iv. (1889) pp. 171–3.

† Zool Jahrb. (Abth. f. Anat.), iii. (1889) pp. 611–52 (2 pls.).

logically correct. Analogous cases may be cited from Kükenthal's observations on lymphoid cells in Annelids and Semon's studies on Holothurians.

In the third and last place the author describes some points in the development of the wing of Lepidoptera. The eversion of the wing in the passage of the larva into the pupa stage is effected by blood-pressure. In the young pupal wing there are, in addition to the large tracheæ, blood-corpuscles which are more or less charged with nutrient material. It is important to note that the matrix of the tracheæ gradually disappears altogether, and that in the wing of the imago even the very delicate intima can no longer be found. Scales and hairs are formed on the first day of the pupal stage; both structures are, in general terms, outgrowths of greatly magnified hypodermis cells. The mother-cells of the hairs are much larger than those of the scales.

The fusion of the wing membranes begins at a very early stage, and in a peculiar manner. Clefts appear in the hypodermis owing to the cells increasing in length, and separating from one another. A continuous membrane formed of protoplasm is present, which may be called the ground membrane of the epithelium. Both blood-corpuscles and blood fluid make their way through this membrane. Between the two wing membranes is a system of pillars formed by the hypodermis. The clefts in the hypodermis function as blood-spaces, and the fluid clearly serves to nourish the hypodermis of the wing.

Later on, the two wing membranes are, in consequence of the considerable growth of their surface, arranged in a number of small folds. The median membrane formed by the fusion of the two is absorbed so that the wing is traversed by a number of thin pillars which connect the two membranes. In the imago the hypodermis of the wing is reduced in a extraordinary manner, while the mother-cells of the scales have almost completely disappeared. Tracheæ too are no longer to be found. The cuticle of the wing does not appear till a comparatively late stage, and its appearance sets a limit to the growth of the surface of the wing. The wing-ribs, as Semper calls the tubes which accompany the tracheæ in the veins of the wings, are, the author has observed, connected with the tracheæ. A rib, when complete, has in cross section the form of a tube which is generally cylindrical, and is lined by a very thin chitinous intima, which carries delicate tracheal branchlets. In the ribs there is a central cord which in longitudinal section exhibits a distinct longitudinal striation; this cord appears to be excreted by the cells of the wall of the tube, and does not appear to be, as Semper has supposed, nervous in nature.

Before the wing gets its characteristic marking, owing to the differentiation of the scales, it is coloured red by a pigment deposited in the cells of the hypodermis. The characteristic marking appears in a very short time, and is, therefore, difficult to investigate. The study of these markings has not as yet enabled the author to make out definitely the phylogenetic development of colour-pattern in the way effected by Weismann for caterpillars, and by Eimer for Vertebrates; a few points, however, appear to be indicated.

Number of Polar Globules in Fertilized and Unfertilized Eggs of Bees.* — Prof. F. Blochmann has recognized the importance of

* Morphol. Jahrb., xv. (1889) pp. 85–96 (1 pl.).

determining the number of polar globules in ova which, without being fertilized, become developed into male animals. For this purpose, as for some others, the egg of the Honey Bee is well adapted, and it is here always easy to keep the unfertilized from the fertilized eggs. The first polar nucleus always remains undivided, as is the case in some other Insects; in *Apis* the second polar nucleus often appears to be divided. The fact that the three nuclei are not, as in some cases, due to a division of the first nucleus is proved by the position of this nucleus, which is always found just under the surface of the egg and separated by some distance from the other two. The female pronucleus soon becomes vesicular in form, and makes its way to the axis of the egg, when it becomes converted into a spindle, and by further divisions gives rise to the nuclei of the blastoderm-cells. The polar nuclei undergo changes similar to those seen in *Musca vomitoria;* they do not, however, become vesicular in form, but approach one another and are inclosed by a rather large vacuole of the superficial protoplasm which is free from yolk. In this vacuole they break up into fine chromatin granules which are then scattered through the whole cavity of the vacuole. We may suppose that the contents are, later on, removed from the egg.

In fertilized ova the ovarian nucleus undergoes the same division as in the unfertilized. The result of the investigation—that the unfertilized ova form two polar globules—or, more correctly, two polar nuclei by two divisions of the ovarian nucleus, is confirmed by the results which Platner has obtained with *Liparis dispar.*

With regard to the bearing of these observations on the theories of Weismann, the author says that he thinks it is better to extend the investigation in all directions, and only afterwards to construct a theory, instead of basing an extensive speculation on a limited number of facts; the speculation, indeed, is only too soon shown to be untenable, as it is in contradiction to observed facts.

Respiration of the Ova of Bombyx.*—Profs. L. Luciani and A. Piutti have made an elaborate series of experiments on the respiratory phenomena in the ova of the silkworm. Respiration is slight during hibernation; at the ordinary temperature of 8°–10° C., a kilogramme of ova produced only about 18 centigrammes of CO_2 in 24 hours. The respiratory activity is lessened by lowering the temperature, by desiccation, and by restricting the space. Both cold and drought induce "absolute latent life," when the respiration ceases. During artificial incubation, with a gradual rise of temperature, there is a regular increase in the quantity of CO_2 given off per unit time, till towards hatching the amount is 259 times greater than that at 0° C. during hibernation. The respiratory activity also varies with the developmental activity. The relation of the CO_2 exhaled to the oxygen absorbed—the "respiratory quotient"—is expressed in a fraction increasing to unity and beyond that as development progresses. There is therefore in all probability a production of less oxygenated molecules and an increasing sum of potential energy.

Termites.†—Prof. B. Grassi has a preliminary note containing further information on these interesting insects. He finds that colonies of Termites annually produce an enormous number of sexually mature

* Bull. Soc. Entomol. Ital., xx. (1888) pp. 69–99.
† Zool. Anzeig., xii. (1889) pp. 355–61.

individuals. Those which become mature in spring get completely developed wings and then leave the maternal nest to become the true kings and queens of new colonies; this, however, very rarely happens to them. Those which become mature in summer copulate and multiply (complementary kings and queens). The complementary kings die before the beginning of winter, so that the queens alone survive; these cease to deposit eggs in winter and spring, but begin again in May; they then make use of the sperm which they have kept stored up in their spermatheca since the preceding autumn. The author does not know how long the complementary queens may live, but it is probable that they die when the next set of complementary kings and queens becomes mature. The various forms of Termites are exhibited in the accompanying table:—

Termes lucifugus.

1. Youngest larvæ.
    - 2. Larvæ, incapable of reproduction
    - 3. Larvæ, capable of reproduction
        - 5. Larvæ of soldiers
            - 7. Soldiers
        - 6. Larvæ of workers
            - 8. Workers
        - 9. Nymphs of Form I.
            - 12. Winged forms
                - 14. True king and queen
            - 13. Replacement pairs
        - 10. Nymphs of Form II.
            - 15. Complementary pairs.
        - 11. Replacement pairs—only present when 14, 15, and 4 are wanting, or the two latter incompletely represented
    - 4. Replacement pairs—only present when 14, 15, and 11 are wanting, or the two latter are incompletely represented

Abdominal Appendages of a Lepismid.*—Dr. J. T. Oudemans gives an account of the abdominal appendages of the little known *Thermophila furnorum.* They are found on the seventh, eighth, and ninth ventral shields, but do not all appear until the creatures are adult; they appear in order from behind forwards. These processes are not rudimentary organs and therefore have nothing to do with the primitive legs. They are found in males as well as in females, but seem to appear in the latter somewhat earlier than in the former.

Galls produced on Typhlocyba rosæ by a Hymenopterous Larva.†—M. A. Giard calls attention to the death last October of a large number of specimens of *Typhlocyba rosæ;* further investigation has shown that they become the prey of a hymenopterous larva which has a close resemblance to that of *Misocampus.*

* Zool. Anzeig., xii. (1889) pp. 353–5.
† Comptes Rendus, cix. (1889) pp. 79–82.

γ. Myriopoda.

Anatomy of Polyxenus lagurus.*—Mr. F. G. Heathcote gives a description of some points in the anatomy of this Myriopod. The Malpighian tubes differ somewhat from those of its allies; each tube is doubled on itself in such a way as to form a great spherical knot, the greater part of which lies in the semicircular chitinous elevations which are placed at either side of the anus. The nerve-cord shows a greater resemblance to that of the larval *Julus* and also of Chilopods than does the nerve-cord of any other Chilognath with which the author is acquainted.

The chief interest of this form lies in the resemblance presented by some of its anatomical characters to the anatomy of Chilopods. It agrees, indeed, with the Chilognatha in the position of its generative organs and the duplication of some of its segments, as well as in its vegetable feeding habits, but it resembles the Chilopoda in the form of its spermatozoa, which are long and filiform and are contained in spermatophores, in the general structure of its segments, the legs being wide apart, and in the differentiation of the ventral nerve-cord. The peculiar form of the second pair of mouth-appendages and the absence of stink-glands, with the substitution for them of numerous spines as a means of defence, are characters special to the genus. *Polyxenus* seems to have preserved in its anatomy certain traces of its descent from the ancestor common to the two classes of Chilopoda and Chilognatha; to Mr. Heathcote it affords further reason for believing that the Myriopods are descended from a Peripatus-like form, and as opposing their descent from the Thysanura.

δ. Arachnida.

Structure and Function of Spinning Glands of Araneida.†—Herr C. Apstein has not, like most of his predecessors, confined his investigations to *Epeira diadema*. In the Epeiridæ he distinguishes five kinds of glands; the glandulæ aciniformes are those which consist of a tunica propria and an epithelium which exhibits in all its parts the same reaction to staining reagents, whose longitudinal is hardly greater than their transverse diameter, whose efferent duct has no epithelium but a thick tunica intima, and which ends in a spool, which is drawn out into a fine tip. The glandulæ pyriformes consist of a tunica propria and an epithelium, which in its lower parts (or those near the efferent ducts) stains more deeply than in the upper, whose efferent duct has a thick tunica intima but no epithelium, and which ends in a spool with a very small basal and fine short accessory piece. The glandulæ ampullaceæ have a tunica propria and an epithelium, the earlier part of which is cylindrical, and then forms an ampullaceous swelling; the efferent duct, which consists of tunica propria, epithelium, and tunica intima, forms a double fold, and ends in a large spool cut off sharply at its end. The glandulæ tubuliformes vary hardly at all in diameter and end in a large spool. The glandulæ aggregatæ have a wide and much-branched lumen, the efferent duct of which is, in its median part, provided with protuberances filled with cells; their spool is large and has an accessory piece which draws out to a tip. The glandulæ tuberosæ described by Meckel and by Oeffinger have no existence.

* Quart. Journ. Micr. Sci., xxx. (1889) pp. 97–106 (1 pl.).
† Arch. f. Naturg., lv. (1889) pp. 29–74 (1 pl.).

The differences which obtain in the Retitelariæ, the Tubitelariæ, the Citigradæ, the Laterigradæ, the Saltigradæ, the Plagitelariæ, and the Territelariæ are next fully described.

All the glands consist of a secreting portion—glands in the strict sense—which also serve as collecting cavities for the spinning material—and of an efferent duct which opens to the exterior by a spool of varying size. The true gland consists of a tunica propria and a more or less high epithelium. The duct consists of a tunica propria, and of a low epithelium (except in the aciniform and pyriform glands where there is no epithelium) and of a thick tunica intima. The spinning spools consist of a basal and an accessary piece. The upper and lower warts are two-jointed, and the median one-jointed, except in the Mygalidæ where there are three and two joints respectively. In addition to the five glands already enumerated there are also lobate and cribrellum-glands; these are variously distributed in various groups, and the Mygalidæ have pyriform glands only. In the males the number of tubuliform glands may be less than in the females, or they may be completely wanting. With the exception of the Mygalidæ no Spider has less than three or more than six kinds of glands.

The author has made a number of biological investigations, the chief results of which are: the glandulæ aggregatæ prepare the so-called moist filaments from the moist droplets; the tubuliform glands spin the egg-cocoon; the cribrellum-glands prepare the coiled tissue. The lobate glands prepare the spinning material to catch the prey. The pyriform glands form the seizing tissue and attach the separate filaments to firm objects by means of the so-called disc of attachment. The function of the aciniform and ampullaceous glands is not yet known. It is possible that several glands may take part in spinning a web round the prey.

Parasites of Spiders.*—Dr. P. Bertkau communicates some observations on the occurrence of *Mermis* in *Tarentula inquilina* and the resulting sterility of the host. Worm parasites have seldom been observed in Arachnids, but the author has occasionally found them in *Salticus formicarius* and *Tegenaria atrica*. In the species of *Tarentula* above mentioned a large *Mermis*, probably *M. albicans*, was repeatedly found.

In autumn the mature sexes of this spider are to be found; after copulation both disappear. The females conceal themselves and lay eggs; the males die. When mature forms are found in May and June they often contain a *Mermis*. Several cases are described, in one of which the parasite measured 11·3 centimetres. In a male *Tarentula* containing this parasite the sexual function seemed to have been prevented. It was caught in May, with palps full of encysted spermatozoa. Bertkau thinks that copulation had been hindered for some nine months. The act is followed by death; the motive comes as usual from the internal reproductive organs, not from the sperm-laden palps, but the presence of a parasite may entirely alter the habit.

New Acarid.†—Prof. B. Grassi and Sig. G. Rovelli describe a peculiar Acarid, *Podapolipus reconditus* g. et sp. n., an abundant parasite on the Coleopteron *Akis* (or *Acis*) *spinosa*. The parasite belongs to the

* Verh. Nat. Ver. Preuss. Rheinl., xlv. (1888) pp. 91–2.
† Bull. Soc. Entomol. Ital., xx. (1888) pp. 59–63 (1 pl.).

family *Tarsonemidæ;* the body is segmented; the mandibles are slightly developed and stilet-like; tracheæ arise at the base of the rostrum on the ventral surface; there are two curious prominences, like adhesive organs, between the first and second pairs of legs; the first pair of limbs are clawed; there is sexual dimorphism.

Even the young forms are of two distinct sorts; in one set the clawed first pair of limbs and the curious prominences are acquired, but the three posterior pairs of appendages and the caudal setæ are lost. These are females, and acquire sac-like bodies, distended with ova, embryo, and young forms. Others seem to remain small and less modified, and are pigmy males. The enigmatical prominences, the dimorphism, and the extreme degeneration are interesting features in this new Acarid.

ε. Crustacea.

Intestine of Decapoda and its Gland.*—Prof. G. Cattaneo has followed up the researches of Weber, Frenzel, and others, as to the structure of the intestine in Decapod Crustaceans, and the nature of the mid-gut gland. In the intestine proper he distinguishes seven strata, the chitinous cuticle, a layer of cylindrical epithelium, a layer of connective, longitudinal, radial and circular muscles, and an external connective-tissue layer, but has added little to previous researches. His experiments on the function of the gland are more interesting, for they show that it is complex enough to be compared to that of all the Vertebrate digestive glands taken together. The mid-gut gland thus seems well to deserve the title he gives it of "polyenzymatic," which is even wider than "hepato-pancreas."

Early Development of Blastodermic Layers in Isopoda.†—M. L. Roule has investigated the early stages in the development of the blastodermic layers in *Asellus aquaticus* and *Porcellio scaber*. In the former fecundation is followed by the radial division of the yolk into a small number of blastomeres, which, in their turn, divide radially and tangentially to form a compact planula. The walls of the cells are very delicate, and the least pressure causes them to disappear; in sections these walls are not seen and the whole yolk has the appearance of a homogeneous mass, hollowed out by vacuoles, in the interior of which are found the granulations dissolved by the reagents. Later on, a zone of hyaline protoplasm appears at the pole of the egg, which corresponds to the anterior region of the embryo; this zone thickens, then seems to slowly extend itself on the ventral and to rise up again to the dorsal surface. The zone does not, however, extend by itself or independently of the yolk. In sections nuclei appear at the periphery of the yolk; this part then becomes hyaline and the distinction between ectoblast and mesoendoblast becomes apparent.

The history of *Porcellio* is the same, save that there is no preceding segmentation; there is not, in fact, epiboly as one would expect from Bobretzky's observations on the closely allied *Oniscus*.

British Amphipoda.—In the second part of his paper ‡ Dr. Norman treats of the Leucothoidæ, Pardaliscidæ, and Marine Gammaridæ. *Leucothoë imparicornis* is a new species from Shetland; *Lilljeborgia*

* Atti Soc. Ital. Sci. Nat., xxx. (1887) pp. 238–72 (1 pl.).
† Comptes Rendus, cix. (1889) pp. 78–9.
‡ Ann. and Mag. Nat. Hist., iv. (1889) pp. 113–41, 3 pls.

picta sp. n. is discussed at some length. The new genus *Megaluropus* should not be placed, as it has been by Dr. Hoek, among the Pardaliscidæ.

Spermatogenesis in Ostracoda.*—Dr. G. W. Müller finds that the mother-cells of the spermatozoa of Ostracods are matured in the middle of the testicular tubes (*Pontocypris*) or at their ends (Fresh-water Cyprids). These mother-cells either migrate as needed, when a testicular tube always contains spermatozoa of the same age and mother-cells of only two or three sizes (*Pontocypris*, *Cypris compressa*), or a large number migrate during youth and before the formation of the spermatozoa. The mother-cells increase in size from before backwards; in *Cypris dispar*, *Caudona*, and *Notodromas* we always find spermatozoa and mother-cells of very various ages and sizes. The number of cells which divide at one time varies in *Pontocypris* sp. between three and nine, in *Cypris compressa* between three and eight; in *C. dispar* it is two, and in *Notodromas* and *Caudona* four. Each mother-cell ordinarily gives rise to four sperm-cells, and only occasionally to three or two.

True spermatogenesis is effected in very much the same way as in other Arthropods. One or two subsidiary nuclei form a tail-piece which grows to an extraordinarily great length, and is of a very complicated structure; the nucleus is either placed quite at the end of the body so formed (*Pontocypris*) or near the end (Fresh-water Cyprids). The part formed by the subsidiary nucleus is divided into a broader and a narrower portion or head and tail. As the spermatozoa are variously arranged in the testis, and as the complicated apparatus of the efferent ducts require a similar arrangement of all the spermatozoa, it is clear that some of the spermatozoa must be turned round. In *Pontocypris* this is effected by those which go out with the tail forwards, passing into a cæcum, while they, of course, leave with their heads directed forwards. In the fresh-water Cyprids all the spermatozoa pass into the cæcum, and so are all turned round; those that need to be turned the other way enter a pyriform enlargement of the vas deferens which lies between the testis and the cæcum.

The spermatozoa consist of the central filament and three bands which lie beside one another, and are connected with one another along their whole length; of these the median band is contractile. A contraction of this band causes the spiral twisting. The investment of some species is secreted by the spermatozoon itself, while in other cases it is possible that the investment is secreted by the walls of the vas deferens. In one case (*Pontocypris*) at least we can certainly prove that the investment contracts, and that very strongly; in the fresh-water Cyprids the contraction is probably slighter. This contraction probably aids the spermatozoa in escaping from the receptaculum seminis.

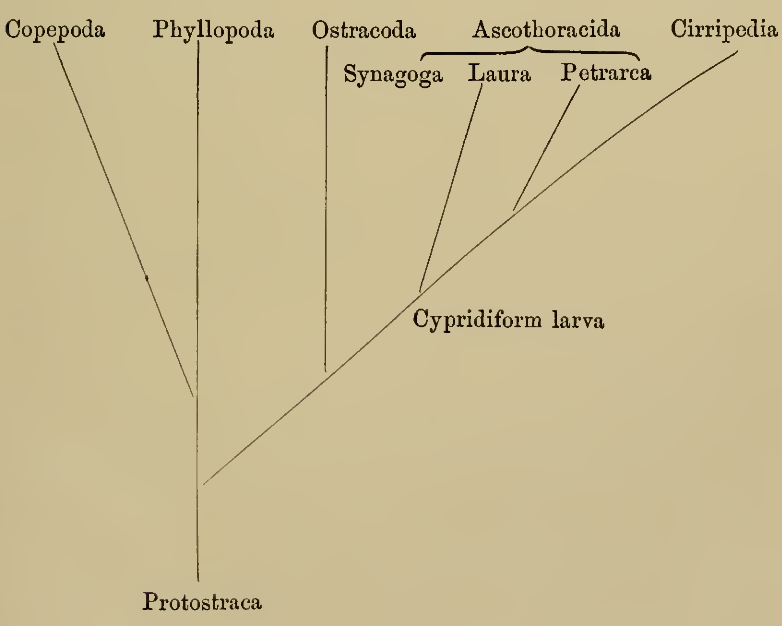
New Pelagic Copepods.†—Dr. W. Giesbrecht gives a list of the pelagic species of Copepoda collected on the voyage of the 'Vettor Pisani' (1882–5), and by F. Orsini from the Red Sea. The list includes 63 species, of which 41 are new. The latter are briefly diagnosed. Nine new genera, *Acrocalanus*, *Calocalanus*, *Leptocalanus*, *Clausocalanus*, *Ctenocalanus*, *Spinocalanus*, *Gaëtanus*, *Undeuchæta*, and *Euchirella*, are distinguished.

* Zool. Jahrb. (Abth. f. Anat.), iii. (1889) pp. 677–726 (2 pls.).
† Atti R. Accad. Lincei (Rendic.), iv. (1888) pp. 330–8.

New Parasitic Copepod.*—Prof. J. Leidy describes a new species of *Chalimus* (*C. tenuis*) found attached to the tail-fin of a *Leptocephalus*; it is considerably less than half the size of *C. scomberi* described and figured by Dr. Baird in his work on British Entomostraca.

Remarkable Crustacean Parasite. †—Dr. G. H. Fowler gives an account of a remarkable crustacean parasite allied to *Laura* and *Synagoga*, and makes some remarks on its bearing on the phylogeny of the Entomostraca. The name proposed for the new genus is *Petrarca bathyactidis*, as it was found, represented by these individuals, in the mesenterial chambers of *Bathyactis symmetrica.*

The animal is nearly spherical externally and measures 1·5 to 1·8 mm. in diameter. The general relations of the body, limbs, and carapace are those of a *Lepas* without a peduncle, with the terminal penis bent forwards under the thorax, the limbs much reduced, the mantle not carrying calcareous plates but greatly swollen by the growth of the internal organs into its substance. The antennæ are terminated by two strong dorsally directed hooks; the oral cone contains a pair of weak crushing mandibles, and behind it there are six pairs of thoracic appendages, of which the last five are simple leaf-like flabella; they are all devoid of hairs or spines. The body is prolonged into a trumpet-shaped penis slightly bifid at the free end. The epidermis is a single layer of flattened cells and is covered by a thin chitinous cuticle; there is no evidence of any calcareous deposit. The lining membrane of the



* Proc. Acad. Nat. Sci. Philad., 1889, p. 95.
† Quart. Journ. Micr. Sci., xxx. (1889) pp. 107–21 (1 pl.).

hepatopancreas and alimentary canal consists throughout of well-marked cubical cells and shows no specialization in any particular region.

The nervous system consists of a minute supra-œsophageal mass of transverse nerve-fibres devoid of nerve-cells—a curious result of the degraded habit of life—of two circumœsophageal commissures with nerve-cells, and of a comparatively thick ventral cord well supplied with cells. No eyes or other sense-organs were recognizable. The animal is hermaphrodite, and Dr. Fowler was able to make some observations on the course of spermatogenesis.

Petrarca is much more degraded than *Laura*; no head region is distinctly marked off as such, only one pair of mouth appendages is recognizable, the thoracic appendages are much simpler in character, the abdominal region has almost disappeared, and segmentation occurs only in the posterior region of the body. Both genera, however, as well as *Synagoga*, belong to the Ascothoracida.

The author discusses the views as to the relationship of the various groups of the Entomostraca, and presents his own in the tabular form as given on preceding page.

Vermes.

a. Annelida.

Formation of Stolons in Syllidians.*—M. G. Pruvot discusses separately the formation of stolons in Syllidæ and Autolytidæ. In all cases the stolons are produced by fission, which carries off a certain number of indifferent preformed segments. The first phenomenon is the accentuation of the groove which separates two consecutive segments; this causes the upper and lower trunks to become morphologically distinct from one another; the first then regenerates its caudal extremity, and the second reforms its cephalic extremity by a process which is exactly comparable to that which happens when a real section is made between them.

Natural History of Annelids.†—M. L. Vaillant has published what may be regarded as a continuation of the well-known work of Quatrefages. In the first part, which alone is yet published, he deals with the Lumbricidæ, Lumbriculidæ, and Enchytræidæ on the methods of Quatrefages' work. Considering the large numbers of species described during the last three years, it seems a pity the work is not up to date.

Phymosoma varians.‡—Mr. A. E. Shipley has investigated the anatomy of this West Indian Gephyrean. The head has a crown of tentacles, of which there are usually eighteen, arranged in a horse-shoe-shaped lophophore, which is dorsal to the mouth. The mouth is crescentiform. The cavity which represents the pre-oral lobe has a peculiarly pigmented, curiously wrinkled epithelium; this is continuous with the brain, and from it two sensory pits descend into that organ. At the posterior end of the introvert immediately behind the head a thin but very extensible collar is attached; the anterior end of this collar is free, and when the introvert is inverted, it completely covers the head. The ectoderm, except in the most anterior region, is one cell thick; it is curiously vaulted and leaves irregularly scattered spaces between it and the outside of the circular muscles, in which a nutritive fluid probably circulates.

* Comptes Rendus, cviii. (1889) pp. 1310–3.

† 'Histoire naturelle des Annulés marins et d'eau douce,' iii., 1ère partie, 8vo, Paris, 1889, 340 pp.

‡ Proc. Roy. Soc. Lond., xlvi. (1889) pp. 122–6.

There is nothing peculiar in the general anatomy of this Gephyrean, as seen by the naked eye. The author gives the name of skeletal tissue to a peculiar form found in the collar and tentacular crown. The cells composing this tissue are roundish, with large nuclei, and their protoplasm is traversed by numerous fine lines. It seems to support and strengthen the structures in which it is found, and from its position serves as a firm hold for the insertion of the retractor muscles of the introvert which are attached just behind it. The cavity of the alimentary canal is diminished by numerous ridges. There are two kinds of blood-corpuscles, the larger of which are found in the body and are oval in outline, with a spherical nucleus. The smaller are found in a closed series of spaces, usually termed the vascular system. This space may be described as consisting of three parts all communicating with one another, and the whole is lined by a flat epithelium.

Each nephridium consists of a bladder and a true secreting part; both are well supplied with muscular fibres, and are very contractile. The bladder opens to the exterior by a circular mouth and to the interior, or body-cavity, by a ciliated opening which has the shape of a flattened funnel. The lumen of the secretory part is broken up into a number of side chambers, and the whole is lined by a very peculiar epithelium; the cells of this are columnar in shape, and are crowded with minute spherical granules; many of them have at their free end a bubble or vesicle in which these granules accumulate. From time to time these vesicles break off, and lie in the lumen of the secretory part of the bladder; they are no doubt extruded from the body. The whole process is very like the secretion of milk in a mammary gland. In both sexes the reproductive organs form fimbriated ridges, which are attached to the bases of the ventral retractor muscles, and are continuous across the interspace between the two, ventral to the nerve-cord. The cells forming these ridges are continuous with the peritoneal lining of the body-wall.

The ganglion cells of the brain are mostly small and bipolar, but on the posterior surface there are a certain number of unipolar giant ganglion cells, at least four times as large in diameter as the smaller cells. The ventral nerve-cord has no trace of a double origin or of segmentally arranged ganglia. The sensory organs are represented by sensory pits in the brain, and by ectodermal sense-organs in the introvert.

γ. Platyhelminthes.

Otoplana intermedia.*—Dr. G. du Plessis gives a short account of this interesting new Turbellarian found near Nice; it is one of the few known marine Triclads. It is blind, and has no trace of external or internal eyes, or even of eye-like pigment-spots. There is, however, a frontal otocyst of just the same structure as that of all the Monotidæ. Right and left of it there are two dorsal ciliated fossets similar to those of Nemertines and of the Cylindrostomata, which are very near *Monotus*. The periphery of the body is provided at equal intervals and on either side by tactile setæ arranged symmetrically in pairs. On the frontal edge they are very robust at the base, and have the form of strong spines. The brain, which is discoidal, and the nerves which are given off from it are similar to those of the Monotidæ. The skin also resembles

* Zool. Anzeig., xii. (1889) pp. 339–42.

that of the Monotidæ in that it contains among the ordinary ciliated cells others which are agglutinating; in these the cilia are replaced by rough bodies which look like microscopic brushes; by the aid of these the delicate worms attach themselves firmly to the smoothest bodies. The reproductive apparatus is also similar to that of the Monotidæ, and the creature is monogonoporous. The digestive apparatus, on the other hand, is elegantly branched, and even in its slightest details resembles that of other Triclades.

It is necessary to form a new genus for this Planarian, on account of the presence of an auditory vesicle, of tactile setæ, and of ciliated pits, which are characteristics of the Rhabdocœla.

δ. Incertæ Sedis.

New Species of Phoronis.*—M. L. Roule describes a new species of *Phoronis* found at Cette. The individuals live in cylindrical tubes, with resisting walls, formed by a delicate chitinous layer strengthened by numerous small débris of sand. The tube varies from six to ten cm. in length and is from one and a half to two mm. wide; the animal is three to four cm. long and one or one and a half mm. wide; it has from forty to fifty tentacles. In all these points the new species is very different from *P. hippocrepis.* The presence of two species of *Phoronis* in the Mediterranean explains the presence of two types of *Actinotrocha;* for the new *Phoronis* the specific name of *Sabatieri* is proposed; individuals are to be found on the free valves of *Tapes.*

New Marine Larva.†—Mr. J. W. Fewkes describes a remarkable larva found in the Bay of Fundy and allied to *Mitraria.* The body is hat-shaped with a narrow rim, gelatinous and transparent; there are two ciliated regions, one at the apex and the other on the rim. A bifid protuberance hangs down from the pole of the larva opposite the apical tuft of cilia, and from it arise two fan-shaped bundles of provisional setæ; these can be drawn together or separated. Under the apex there is a thickening of the epiblast which is connected with the marginal belt by means of a fine thread. There is a long tubular œsophagus, the inner wall of which is richly ciliated, and which opens into a simple elongated stomach without cilia. The larva, when expanded, is from ·15 to ·2 mm. in diameter.

This curious form has Chætopod, Brachiopod, and Bryozoan features, and may be supposed to resemble the archetype or ancestral form of these three groups. It is suggested that the term *Mitraria* should have its significance enlarged and be the name for the common ancestor of these three groups. Its characteristic features are (1) an apical tuft of cilia mounted upon an epiblastic thickening; (2) a mouth surrounded by a ciliated rim; and (3) a protuberance near the mouth from which arise embryonic setæ.

Echinodermata.

Ludwig's Echinodermata.‡—Prof. H. Ludwig has published the fourth part of this work. He continues his account of the calcareous ring, and doubts whether it is ever altogether absent; and then describes

* Comptes Rendus, cix. (1889) pp. 195–6.
† Ann. and Mag. Nat. Hist., iv. (1889) pp. 177–81.
‡ Bronn's Klassen u. Ordnungen, ii. 3, Echinodermata (1889) pp. 81–128.

the retractor muscles. In the description of the water-vascular system the tentacles are first considered; when these are of different sizes the smaller are always radial and the larger interradial in position. Prof. Ludwig is of opinion that a tentacle is homologous with a pedicel, but that it is, as a rule, distinguished from it and advanced to a higher grade of development by the possession of branches or terminal lobules which are only exceptionally found on the pedicels. The great variations exhibited by the pedicle are described and with them the ambulacral papillæ are discussed. The circular canal and Polian vesicles are next described; the latter vary considerably in number, for while many have only one, *Holothuria oxurropa* may have from eight to twelve, *Chiridota rigida* fourteen to sixteen, and some of the *Synaptæ* have fifty and more. The radial canals are next described and their topographical relations made clear by a diagram of a transverse section through the body of a Holothurian. After describing the tentacular canals and ampulla, and the canals and ampullæ of the pedicels, the author commences the description of the stone-canal.

Formation of Mesoderm in Echinoderms.*—Dr. E. Korschelt has a memoir, based on observations on *Strongylocentrotus lividus*, with regard to this vexed question. The formation of the layer is a problem of some difficulty as in all Echinoderms it arises in two ways. It commences with a more rapid growth of the cells at the vegetative pole than elsewhere; the consequence of this is that at this point the arrangement of the cells becomes irregular; some are very soon pushed into the blastocœl. In the course of development there are no signs of any primitive mesenchym-cells. The mesenchym owes its origin to a large number of cells placed at the vegetative pole. The separation of the wandering cells follows no definite law, and in the blastocœl they lie quite irregularly by one another, so that there are not two mesenchym stripes.

The formation of the mesenchym is very similar in the various groups of Echinoderms, although not in the sense of Selenka—that is, in the presence of primitive mesenchym-cells in all Echinoderms. In the Echinida the mesenchym arises by multiplication of the cells at the vegetative pole of the blastula; a similar mode is seen in Ophiurids and in some Holothurians (*Cucumaria*); in other Holothurians the mesenchym does not arise till a later stage in development—not, that is, till gastrulation begins (*Holothuria*) or is nearly completed (*Synapta*), In the last case the mesenchym takes its origin at the tip of the archenteron, as is the case also in Asterids and Crinoids.

It is possible that we ought to regard as the more primitive form of mesenchym-formation in the Echinoderm that in which the wandering cells break off from the archenteron, rather than their direct origination from the blastoderm, which may have been more lately acquired. In speculations of this kind, however, we must not fail to remember how little we know as to the phylogeny of the Echinodermata.

Asteroidea of the Voyage of the 'Challenger.' †—Mr. W. Percy Sladen's bulky memoir deals not only with the Starfishes collected by H.M.S. 'Challenger,' but also those obtained in the expeditions of the

* Zool. Jahrb., iii. (1889) pp. 653–76 (1 pl.).

† Reports of the voyage of H.M.S. 'Challenger' (Zoology), xxx. part li. (1889) pp. xlii. and 893, and atlas of 117 pls. and 1 map.

'Lightning,' 'Porcupine,' 'Knight Errant,' and 'Triton.' In all, 42 new genera and 196 new species are described. The collection made by the 'Challenger' is stated to afford a fair representation of the general character of the Asterid fauna of the globe, so far as known. A large number of abyssal forms have been found and their discovery may be said to have opened a new chapter in the history of the Asteroidea. The archaic characters of a number of the deep-sea forms are highly remarkable, and furnish not only a confirmation of the validity of the classification now adopted, but also give an important clue to the systematic position of many members of the class.

Mr. Sladen does not take the same view of the value of the pedicellariæ as does Prof. Perrier, for he considers that the most archaic forms have the simpler and less complex pedicellariæ, nor have these organs the more subordinate systematic value which the French naturalist also ascribes to them. The more valuable bases for classification are to be sought for in (1) the adaptation of the organism to subserve the functions of respiration and excretion, (2) the character of the ambulacral skeleton, and (3) of the ambital skeleton. The respiratory papulæ may be distributed over the whole body or confined to more limited areas, and these may be called respectively the Adetopneusia and the Stenopneusia. There are two modes of growth in the ambulacral skeleton; the production of the parts may be accelerated in relation to the growth of the starfish, or be retarded, or proceed *pari passi;* here the terms Leptostroteria and Eurystroteria come into use.

The third chief morphological point is the character of the marginal plates; these may develope rapidly, and form an important characteristic throughout life, as in the Phanerozonia, or they may be hidden and insignificant as in the Cryptozonia.

The three divisions to which these three sets of two names apply are essentially equivalent, and the groups are regarded by the author as natural orders in the strictest sense of the term. We have then the Phanerozonia (Stenopneusia; Eurystroteria) as the first order of the sub-class Euasteroidea of the class Asteridea; the families included therein are the Archasteridæ, of which the Pararchasterinæ, Plutonasterineæ, and Pseudarchasterinæ are new; the Porcellanasteridæ, described in 1883 from 'Challenger' specimens; the Astropectinidæ; the Pentagonasteridæ; the Antheneidæ; the Pentacerotidæ; the Gymnasteridæ; and the Asterinidæ.

The second order or Cryptozonia (Adetopneusia; Leptostroteria) contain the Linckiidæ, the new family Zoroasteridæ, the Stichasteridæ, the Solasteridæ, the Pterasteridæ, Echinasteridæ, Heliasteridæ, Pedicellasteridæ, Asteriidæ, and Brisingidæ. A synopsis of the orders and families is given.

After describing the collection with great detail, Mr. Sladen gives a list of stations at which Asteroids were collected, enumerating the species found at each; then follow tables showing the known bathymetrical range of the genera; others which show the nature of the sea-bottom; and finally, there is a list of the known species of recent Euasteroidea with the principal localities, the general geographical and bathymetrical distribution, and the synonyms. The collection of Starfishes seems to be one of the most important of those made by the 'Challenger.'

Cœlenterata.

Revision of British Actiniæ.*—Prof. A. C. Haddon has published the first part of a revision of British Actinians; in this he deals with the Sagartidæ, the Edwardsiidæ, the Halcampidæ, and the Zoantheæ. The general conclusions to which his work has led him may be thus summed up. In larval Actiniæ two mesenteries arise at right angles to the long axis of the œsophagus, and divide the archenteron into two chambers. A pair of mesenteries appear in the larger of the two primitive chambers; a third pair is developed in the smaller of the two primitive chambers, and immediately afterwards another pair of mesenteries appear. A short resting stage now occurs, in which eight mesenteries are alone present, and the corresponding chambers are produced into eight tentacles. This appears to be a characteristic phase in the development of all the Actiniæ hitherto studied, with the exception of *Cerianthus*. There is reason for believing that in most, if not all, these eight mesenteries are homologous with those of the Edwardsiæ; in other words, such forms as *Halcampa*, *Actinia*, *Cereus*, and *Bunodes*, if not all other sea-anemones (except *Cerianthus*) pass through a larval stage which is permanently retained in the adult Edwardsiæ.

The next stage is characterized by the practically simultaneous development of two pairs of mesenteries; these for some time remain imperfect. The fifth and sixth pairs next reach the œsophagus, and constitute the ground or fundamental form of the typical hexamerous Actiniæ. *Halcampus clavus* of R. Hertwig does not advance further.

Stages of Development in terms of mesenteries.	Table of lines of Development of certain Actiniæ.				
12 + 12, 24, &c.				Typical hexameral Actiniæ	
12 + 12			*Peachia* *Halcampa*	(young)	
12			*Halcampa*	(young)	
8 + 4		*Gonactinia*	(young)	(young)	Zoantheæ
8		*Edwardsia*	(young)	(young)	
4	Scyphostoma larva	(young)	(young)	(young)	
2	(young)	(young)	(young)	(young)	Ceriantheæ

A pair of small mesenteries, with their longitudinal muscles facing one another, is developed in each exocœle; this is almost the permanent

* Sci. Trans. R. Dublin Soc., iv. (1889) pp. 297–361 (7 pls.).

condition of *Halcampa chrysanthellum* and *H. arenarea*. These mesenteries grow larger, and other pairs appear successively in every exocœle until a considerable number is developed.

The relationship of the Hydra-tuba and Scyphostoma stages of the Scyphomedusæ (Acalephæ) to the Zoantharia is now generally admitted; a permanent octoradiate condition occurs in *Edwardsia*, but it is difficult to see where the Octocoralla (Alcyonaria) fit in. The time for a classification or phylogeny of the Actiniæ as a whole, has not yet arrived, but the table (see preceding page) shows the line of development of some of them.

Above the black line new mesenteries arise in pairs within each exocœle, and radially; below it the mesenteries appear in pairs bilaterally with respect to the long axis of the œsophagus.

Actinology of the Bermudas.*—Dr. J. P. McMurrich gives an account of the Actinians collected by Prof. Heilprin in the Bermudas. *Aiptasia* cannot be separated from the Sagartidæ, and as it has gonads on the first order of septa, the definition of the family given by R. Hertwig must be amended so far as the statement that the principal septa only are perfect and at the same time sterile is concerned. *Condylactis passiflora* has grass-green tentacles, owing no doubt to the enormous number of zooxanthellæ contained in the endoderm. The author not only considerably amends Andres' definition of the family Phyllactidæ, but removes it from the Stichodactylinæ to the Actiniæ. A new genus—*Diplactis*—is formed for two new species in which the fronds have a tentacular appearance, so that it seems as if there were two series of tentacles, an inner and an outer. *Mammilifera tuberculata* is peculiar for the presence of zooxanthellæ in its ectoderm; as a rule these bodies are found only in the endoderm in adult Actiniæ. It is possible that their presence is due to the thick cuticle and subcuticula preventing a rapid aeration of the ectoderm cells, and so, by favouring the accumulation to a certain extent of carbonic acid, producing favourable conditions for the growth of the parasitic algæ.

Angelopsis.†—Mr. J. W. Fewkes discusses the relationship of *Angelopsis* to certain Siphonophora taken by the 'Challenger,' and makes some severe remarks on Prof. Haeckel's report on those animals. He points out that he was the first to give an account of an Auronectid, "the revelation of which group Haeckel styles 'one of the most splendid discoveries of the 'Challenger.''"

Porifera.

Structure of Flagellated Chambers in Sponges.‡—Dr. R. v. Lendenfeld points out that in all existing descriptions and figures of the flagellated chambers of sponges, with the exception of those lately published by Sollas and by Dendy, it is explicitly or implicitly stated that the flagellated chambers are spaces in the sponge, on the surface of which the collared cells stand. This, however, is not so, for the space between the collared cells is filled by a transparent substance which is very similar to the ordinary ground-substance of the intermediate layer of sponges. In other words, the collared cells do not stand freely on the surface of the intermediate layer, but are sunk into it. As a rule, no

* Proc. Acad. Nat. Sci. Philad., 1889, pp. 102–26 (2 pls.).
† Ann. and Mag. Nat. Hist., iv. (1889) pp. 146–55 (3 figs.).
‡ Zool. Anzeig., xii. (1889) pp. 361–2.

boundary-line can be made out between this substance and the subjacent ground-substance. The membranes described by Sollas and Dendy appear to be nothing more than the boundaries—sometimes particularly distinct—of the substance which lies between the collared cells.

Korotnewia desiderata and the Phylogeny of Horny Sponges.*—Dr. N. Poléjaeff finds in a peculiar horny sponge called *Korotnewia desiderata* that the substance of its fibres corresponds only to that of the medulla of the heterogeneous horny fibres; the elements that form the fibres are all polyhedral. The author believes that this discovery confirms his view that the polyhedral cells form the medulla of the fibres and the cup-shaped cells their margin, and that every horny fibre has from the first its definite thickness. As the polyhedral are less specialized than the goblet-shaped elements, it follows that the skeleton of the ancestral form of the horny sponges is not to be sought for in the Spongeliidæ, but rather among the Darwinellidæ. The fact that the canal system of the Darwinellidæ is less differentiated than that of the Spongeliidæ supports this view. As to the modern speculations suggesting the polyphyletic origin of the Keratosa, the author remarks that one ought not to separate artificially what one can unite naturally.

New British Sponge.†—In his account of the Porifera of the Liverpool Marine District, Dr. R. Hanitsch describes a new genus *Seiriola*, for which he institutes a new family. This belongs to Sollas' group Streptastrosa, for it is an astrophorous sponge in which one of the microscleres is some form of spiraster; the family is defined in the following terms:—"The ectosome forms a cortex. Chief megascleres triænes. The choanosomal mesoderm is cystenchymatous. *S. compacta* sp. n. was found at Puffin Island, where it forms a knob-like mass. In this report seven species are added to the list of forms recorded from that neighbourhood, one of which—*Reniera semitubulosa*—is new to British seas.

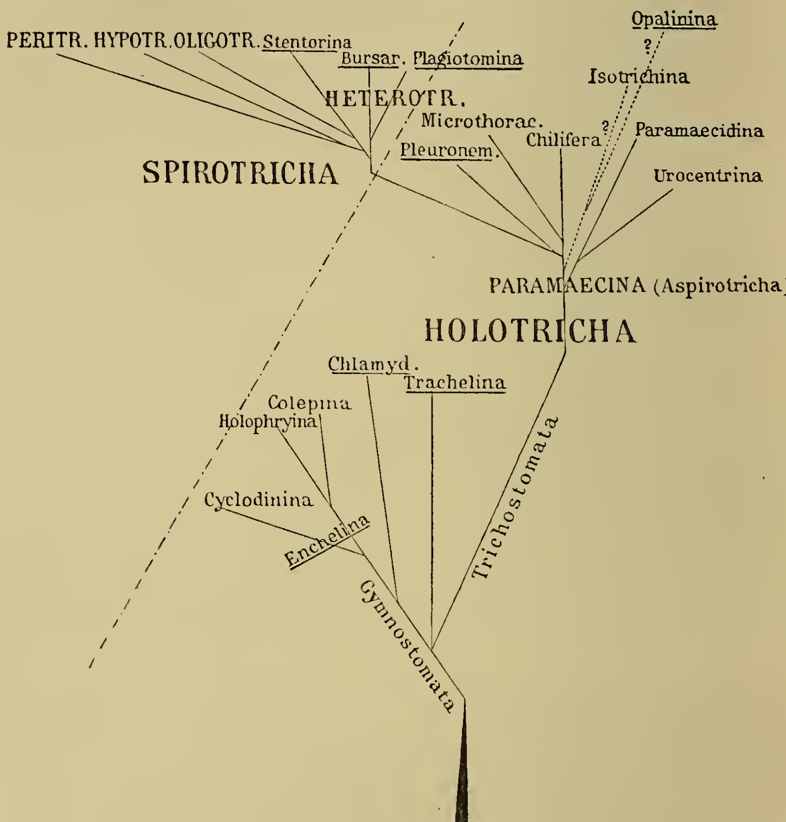
Protozoa.

Chlorophyll in Animals.‡—M. P. A. Dangeard, who remarks that chlorophyll-corpuscles have never yet been observed in the Flagellata, reports its presence in *Anisonema viridis* [*e*] sp. n., which contains a large number of green granules, placed in the ectoderm. The author, who believes that these green bodies are parasitic Algæ, notes that their presence is connected with the existence of a gelatinous secretion, in the interior of which the individuals are reproduced by division. A similar gelatinous investment is found in *Ophrydium versatile*, where the cysts resemble a large *Pleurococcus;* the protoplasm seems to be coloured uniformly green, the membrane is thick and striated by bands which intercross like those of the cysts of *Stylonychia mytilus*. We do not yet know how the green corpuscles behave when the host is encysted; if they lose their individuality the author recognizes that it will be necessary to abandon the idea of their being parasitic. It is possible, however, to be certain by means of reagents that the green corpuscles remain distinct.

Bütschli's Protozoa.§—Prof. O. Bütschli continues his systematic description of the Ciliata. The second suborder, or Spirotricha, is

* Zool. Anzeig. (1889) pp. 366–7.
† Liverpool Biol. Soc., iii. (1889) pp. 155–73 (3 pls.).
‡ Comptes Rendus, cviii. (1889) pp. 1313–4.
§ Bronn's Klassen u. Ordnungen, i., Protozoa (1889) pp. 1713–1840.

divided into four sections: the Heterotricha, among which *Balantidiopsis* is a new genus for *Balantidium duodeni* Stein, the Oligotricha, the Hypotricha, the Peritricha. The author's views as to the phylogeny of the subclass Ciliata are shown in the accompanying table:—



The author next proceeds to discuss certain physiological-biological points, commencing with the phenomena of regeneration; those of movement are next considered, and then the processes of digestion. The interesting chapter on modes of life contains a list of parasitic forms arranged under the heads of their respective hosts, from which Birds and Reptiles are absent. The influences of temperature, of chemical substances and of electricity are described. The part before us concludes with an account of the parasites of the Ciliata.

Parasitic Trichodina.*—Herr J. Carrière describes a species of *Trichodina* (? *pediculus*) which is found living in the lateral canal or wall as on other parts of the body of *Cottus gobio* and eating blood and lymph-corpuscles. In bony fishes there appears to be normally a constant and often very well marked migration of lymph-cells into the

* Arch. f. Mikr. Anat., xxxiii. (1889) pp. 402–15 (1 pl.).

epidermis. These are best and most numerously seen in the lowest layers of the stratum Malpighii; thence they can be traced through the whole of the epidermis as far as the uppermost layers.

Parasitic Protozoa in Hooping Cough.*—Some time since Dr. C. Deichler asserted that parasitic Protozoa were to be found in the matter coughed up in hooping-cough, and that they had some ætiological connection with the affection. As this conclusion was not accepted, he has made some further observations. There appears to be a cycle of forms belonging to a ciliate animal. Those which are regarded as embryos are circular in form and have a double contour; the circle varies in size, but is ordinarily as large as the larger epithelial round cells found in the sputum. In the vacuolar space inclosed by the ring there is a clear vesicle or a corpuscle provided with highly refractive granules of the size of a lymphoid cell. This vesicular or granular body carries a circlet of fine, clear cilia which move actively. The ciliated and actively moving embryos come to rest after a time and undergo further development. In the more developed bodies the contents break up into a granular protoplasm, and the nucleus has a double contour. The embryo gives rise to a distinctly characterized unicellular organism. The amœboid cells of this stage vary both in form and size, and are provided with hairs. The author has also observed encystation; the encysted forms often break up into a number of more or less large, rounded or oval fragments, and this breaking-up appears to be due to cold or to the drying up of the mucus. From these fragments cells are again produced, which vary in size with the fragment from which they take their origin.

Of similar parasites observed in Man the author remembers only *Balantidium coli*, which, though more highly organized, exhibits many analogies with the parasite here described.

Micro-Organisms in Paunch of Ruminants.†—M. A. Certes calls attention to the presence of glycogen in the Infusoria found in the paunch of Ruminants, and especially of Roedeer. In *Entodinium* there is a certain localization of this material, while in *Isotricha* it appears to be uniformly distributed through the organism. In the Roebuck there was found a single species of *Ophryoscolex* which is very small and has no caudal appendage; the species is very abundant, and has associated with it a cruciform Flagellate, some of the examples of which have two flagella instead of one; the author proposes to call this form *Ancyromonas ruminantium.* Microbes characterized by their physiological properties rather than by their form are found in abundance in the paunch of Ruminants, and it is very probable that they play an important part in digestion.

Intimate Structure of the Plasmodium Malariæ.‡—Prof. Celli and Dr. Guarnieri have by the methylen-blue method made observations on the intimate structure of the plasmodium, both in the amœboid and crescent-shaped conditions.

They find that in all plasmodial forms two substances can be distinguished: the first peripheral, a kind of ectoplasm, is more refractive and

* Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 303–9 (1 pl.).
† Journ. de Micrographie, xiii. (1889) pp. 277–9.
‡ Riforma Medica, 1888, Nos. 208 and 236. See Centralbl. f. Bakteriol., v. (1889) pp. 91–3.

more deeply stained by methylen-blue; the second, an internal substance or entoplasm, more centrally disposed, is less refractive and less deeply stained.

In the endoplasm of the pigmented amœboid forms is distinguishable both in the unstained and stained conditions a nucleus, within which are 1–3 more deeply stained nucleoli. Without the nucleus is a vacuole.

The authors have, further, observed that in one and the same malarious patient the process of reproduction is effected in three different ways:—(1) The division of the protoplasmic substance is complete, many different corpuscles being formed, while of the mother plasmodium only the pigment-corpuscles remain. (2) The division of the protoplasm is incomplete, one part of it remaining together with the pigment-granules as an irregular granular mass. (3) The pigment becomes arranged in small circles surrounded by protoplasm. From this originate small pigmented bodies, some of which are in connection with the parent, while others present a pigmented flagelliform prolongation.

The transition from the crescent shape to the oval, from this to the round, with the pigment heaped up in the centre, and finally to the flagelliform condition, can be observed on the hot stage of the Microscope.

Assuming that all these forms belong to one and the same species, the *Plasmodium malariæ* would have two chief phases of endocellular development in the blood, viz. those peculiar to the amœboid and those peculiar to the crescent-shaped varieties, under the latter term being included the spindle, oval, flagellate, and round forms.

The authors consider, from its morphological characters, that the *Plasmodium malariæ* should be classed with the Sporozoa, and, to express their position more accurately, placed under the class Gregarinidæ, Order Coccidiidæ.

BOTANY.

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

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Formation and Growth of the Cell-wall.†—Herr E. Zacharias has investigated this subject in the case of the rhizoids of *Chara fœtida*. The membrane of the apex of the hair becomes considerably thickened when the nodes on which the rhizoids grow are removed from the plant and cultivated, the thickening becoming very considerable in the course of a few hours. The first indication of this thickening is a layer of minute granules which is deposited on the membrane of the apex of the rhizoid; the exact manner in which these granules are formed out of the protoplasm is not clear; but in the course of a few minutes they have formed themselves into a layer of extremely delicate rods, placed vertically to the membrane, which gradually become longer and thicker, and finally unite into a continuous layer of cell-wall. The chemical reactions of the original granules could not be determined; but the rods very soon show a distinct cellulose reaction with chlor-zinc-iodide.

It must be concluded from the above that, in this case at all events, the cell-wall increases in thickness by the deposition of a new formation which is excreted from the protoplasm in the form of a layer of minute granules, from which is developed a layer of rods manifesting the reaction of cellulose. We have not here any direct transformation of a peripheral layer of protoplasm into cellulose; there is a much closer resemblance to the new formation of a cell-wall in cell-division. The young dividing-wall between two sister-cells of the rhizoids of *Chara* consists in the same way of minute rods placed vertically to the growing wall, which subsequently unite into a continuous layer.

After its first formation the thickening-layer of *Chara* continues to increase considerably in thickness; but there is no further trace of any new-formation, nor of an inner lamella differing in structure or reactions from the rest of the thickening-layer. There is certainly here no constant apposition of fresh layers of cellulose on the inner surface of those previously in existence; and in some rhizoids even the formation of the primary layer, as above described, could not be detected. The growth in thickness of the cell-wall therefore takes place either by intussusception or by the successive deposition of minute particles of cellulose on the cell-wall. Whether the superficial growth takes place by intussusception or by simple stretching could not be determined; but the facts seem rather to favour the first of these theories.

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

Pure Chlorophyll.‡—Herr A. Hansen gives a summary of the existing chlorophyll-literature, now agrees with the view of Tschirch

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

† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 107–32 (3 pls.); and Ber. Deutsch. Bot. Gesell., vi. (1888) Gen.-Vers.-Heft, pp. lxiii.–v.

‡ 'Die Farbstoffe des Chlorophylls,' 88 pp. and 2 pls., Darmstadt, 1889. See Bot. Centralbl., xxxviii. (1889) p. 632.

that the substance previously described by him as chlorophyll-green is in reality a compound of that substance with sodium. He has now succeeded in separating pure chlorophyll-green by the following process.

Grass-leaves are boiled in water from a quarter to half an hour, then washed in water, pressed, and dried in the dark. The chlorophyll-pigment is then extracted with boiling alcohol, and the solution saponified by heating for three hours with a slight excess of caustic sodium. The excess of sodium is converted into carbonate by carbonic acid, and the mixture thus obtained dried in a water-bath. The chlorophyll-yellow is then extracted by ether, in which the compound of chlorophyll-green with sodium is quite insoluble, and afterwards by a mixture of equal parts of alcohol and ether, in which it is only slightly soluble, and the residue again by a mixture of equal parts of alcohol and ether and phosphoric acid. This sets free the chlorophyll, which dissolves in the mixture of alcohol and ether, and can be evaporated as a shining black-green perfectly solid brittle substance, insoluble in water, benzol, and bisulphide of carbon, soluble with difficulty in pure ether, easily in alcohol. The solution has a beautiful pure green colour, which becomes red and strongly fluorescent when concentrated. It offers great resistance to reagents, especially mineral acids. Its exact composition has not been ascertained, but it contains iron and nitrogen.

The author then describes the process for obtaining pure chlorophyll-yellow, which crystallizes in orange-red crystals, insoluble in water, but soluble in alcohol, ether, chloroform, and benzol with a dark yellow, in bisulphide of carbon with a red colour. The yellow chlorophyll of flowers and fruits, and that contained in the petals of the poppy, is identical with the chlorophyll-yellow of leaves.

The optical properties of the various chlorophyll-pigments are then described; and finally, the mode in which these pigments are contained in living chloroplasts. The author states that the green substance which fills up the vacuoles of the chlorophyll-grains is not a solution, but consists of combinations of the two chlorophyll-pigments with fatty acids, which possess a half-solid consistence; and the same is true of the chromoplasts.

Physiology of Tannin.*—Herr G. Kraus gives a *resumé* of the most trustworthy investigations that have yet been made of the nature and function of tannin; the mode of investigation being Lœwenthal-Schroeder's, viz. trituration with chamæleon, and extraction with water until the water becomes perfectly colourless.

Tannin is produced in the leaves under the influence of light; its decrease when the light is removed, is due, not to its decomposition, but to its transference to the stem and branches, and a fresh formation of secondary tannin, as it is termed by the author, takes place in the newly-formed organs, even in the dark. The conditions for the production of tannin are, in general, the same as those for carbonic assimilation, and the formation of this secondary tannin is closely analogous to the similar phenomenon in the case of starch.

The author regards tannin, from a physiological point of view, simply as an excrementitious product, and also, in some cases, as serving to protect the plant from being devoured by animals, or from decay.

* 'Grundlinien zu einer Physiologie d. Gerbstoffs,' 8vo, Leipzig, 1889, 131 pp. See Bot. Centralbl., xxxviii. (1889) p. 447.

Herr M. Westermaier,* commenting on Kraus's conclusions, points out that, according to his own observations, tannin does in some cases serve as a reserve-material for the building-up of new tissues, as in that of the formation of roots on the branches of *Salix*.

Formation of Calcium oxalate in plants.†—Herr F. G. Kohl contends that lime can enter into soluble combinations with the carbohydrates in the tissues of plants, and that it is in the form of these compounds that the transference of lime takes place from one part of the plant to another. He has obtained a compound of this kind of grape-sugar and lime in both the solid and the dissolved condition. The organs, therefore, where starch and other carbohydrates are stored up—rhizomes, tubers, bulbs, seeds, bast-fibres, &c.—are also those where the separation of calcium oxalate takes place. Moreover, all organs where albuminoids are being formed have a decided acid reaction from the presence of oxalic acid. This is readily proved in the case of growing points. If light is excluded, calcium oxalate is formed only in small quantities, or not at all.

Influence of Light on the formation of Calcium oxalate.‡—Herr N. A. Monteverde has demonstrated, by experiments on Papilionaceæ, that the intensity of light has a very powerful influence on the amount of crystals of calcium oxalate formed in the stem and leaves.

Production of Honey in Convallaria.§—Herr S. Almquist describes the mode of production of the honey in the flowers of *Convallaria Polygonatum* and *multiflora*, viz. not from any pit at the base of the perianth-tube, but from the primary veins of the perianth, especially of the sepals. This may probably be the original type from which are derived all the various modes of secretion found in the Liliifloræ, viz. from the central nerve of the petals (*Lilium*, *Fritillaria*, *Gagea*, &c.), from folds between the carpels (*Allium*, *Ornithogalum*, *Hyacinthus*), and from the tissue of the spur (some Orchideæ).

(3) Structure of Tissues.

Foliar Vascular Bundles. ||—M. A. Prunet has made a close examination of the changes which the vascular bundles undergo in passing from the stem to the leaves, chiefly in Dicotyledons. The vessels diminish in size, usually becoming more numerous, and have thinner walls; the large secondary vessels disappear, while the primary vessels increase in number. The supporting elements of the bundle—the fibres and the lignified parenchyme—disappear, and, when the bundle has reached the base of the leaf, the vessels, usually arranged in rows placed in a fan-like manner, are accompanied by parenchyme formed of cells which are usually elongated, and have very thin walls. As a rule the largest vessels are near the base of the bundles, thence diminishing gradually towards the periphery, rapidly towards the base. The intercalary parenchyme between the bundles is remarkable from its richness

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 98–102.

† Bot. Centralbl., xxxviii. (1889) pp. 471–5. Cf. this Journal, 1888, p. 445.

‡ Arb. St Petersburg. Naturf. Gesell., xviii. pp. 46–7. See Bot. Centralbl., xxxviii. (1889) p. 486.

§ Bot. Sällsk. Stockholm, March 21, 1888. See Bot. Centralbl., xxxviii. (1889) p. 663.

|| Comptes Rendus, cviii. (1889) pp. 867–9.

in chlorophyll and starch, often accompanied by crystals of calcium oxalate.

From the period of their entry into the leaf the foliar bundles present a return to their primary structure; the vessels increase in size and diminish in number, with increase in the thickness of their walls; the large secondary vessels and the sclerenchyme sometimes reappear; the latter from reasons purely mechanical. In pinnatinerved leaves the largest vessels are often found in the midrib at a certain distance from the base of the lamina; the vessels in the middle, and even towards the apex of the lamina, are frequently larger than those towards the base of the leaf.

All these modifications appear to be in accord with the conducting function of the bundles; the large vessels in the petiole and principal veins may be connected with the turgidity of the leaf.

Anatomy of Floral Axes.*—M. Labarie has studied the differences between the anatomical structure of ordinary stems and of the floral axes in the same plant, which he finds, with great uniformity, as follows:—In the pedicels the cortex is more developed, the vessels of the wood more numerous and smaller, and the pith more developed than in the vegetative axes; and this applies not only to pedicels properly so called, but also to the fruit-bearing axes, i. e. to those special small branches on which alone in certain trees, such as apples and pears, the floral pedicels are developed.

Development of the Vascular bundles of Monocotyledons.†—Fräul. S. Andersson finds that the development of the vascular bundles in Monocotyledons does not differ so widely from that in Dicotyledons as has generally been stated; and that there is, in fact, a close resemblance in this respect between Liliaceæ and Ranunculaceæ. In most of the larger groups of Monocotyledons there are genera in which there is a distinct development of a cambium-zone at an early period, which subsequently more or less completely disappears. This is illustrated by examples from the various families. In *Lilium* there is a distinct intermediate tissue between the xylem and phloem, composed of a meristem which divides by tangential walls, and contributes to the growth of the young bundle. This is also strongly developed in some other genera belonging to the Liliaceæ and to allied orders, while in others it is almost completely suppressed. In the Gramineæ there may be detected, even in old vascular bundles of *Zea Mays*, remains of a cambium-zone composed of cells arranged radially between the xylem and phloem. The same is the case with some palms. In aquatic genera, such as those of Alismaceæ, Naiadaceæ, and Typhaceæ, the vascular bundles are much more feebly developed.

Secretion-receptacles in the Cactaceæ.‡—Dr. C. Lauterbach has examined the structure and mode of formation of the mucilage and gum-cells, crystal-cells, and laticiferous cells, in a large number of species belonging to this order, preceding his description by a general account

* Rech. s. l'anatomie d. axes floraux, Toulouse, 1888. See Bonnier's Rev. Gén. de Bot., i. (1889) p. 91.

† Bih. K. Svensk. Vet. Akad. Handl., xiii. (1888) Afd. 3, No. 12. See Bot. Centralbl., xxxviii. (1889) pp. 586 and 618.

‡ Bot. Centralbl., xxxvii. (1889) pp. 257-64, 289-97, 329-36, 369-75, 409-13 (2 pls.).

of the anatomical structure of the genera *Mammillaria*, *Echinocactus*, *Echinopsis*, *Cereus*, *Phyllocactus*, *Epiphyllum*, *Rhipsalis*, *Opuntia*, and *Peireskia*. The characters derived from the presence of various kinds of secretion-receptacles follow, as a general rule, the other characters which distinguish the genera. The species may be divided, from this point of view, into three categories:—those in which crystal-cells only are present; those which possess both crystal-cells and latex-passages; and those which have both crystal-cells and mucilage-cells.

The mucilage-receptacles are always cells, very rarely having the character of passages; they may contain also separate crystals of calcium oxalate, or sphero-crystals; they are distinguished from the adjacent parenchyme-cells by their much greater size, and are usually found in the chlorophyll-tissue; they do not occur in the root. In some species they are found also in the pith; in the leaves of *Opuntia* they are scattered through the palisade-parenchyme. The latex-receptacles are confined to species of *Mammillaria*, where they have the form of a system of passages; these are of lysigenous, and not, as de Bary states, of schizogenous origin. They occur chiefly in the cortical and palisade-parenchyme, extending also to the root. Crystal-cells are found in all the Cactaceæ without exception; they are usually thin-walled cells containing a single cluster of crystals of calcium oxalate. These are sometimes present in such enormous quantity that they constitute 85 per cent. of the ash, especially in old woody stems.

The mode and place of formation of the mucilage-cells and other receptacles is described in detail in several species and genera. As regards their physiological function, the author regards the mucilage-cells as serving as receptacles for moisture in dry situations and climates, the latex-passages and crystal-cells as serving to protect from the attacks of animals, and as increasing also the rigidity of the stem.

Transfusion-tissue of Coniferæ.*—Herr G. A. Karlsson has studied the structure of the transfusion-tissue in the leaves of a large number of Coniferæ. *Pinus austriaca* may be taken as a type. The cells which surround the true vascular bundles within the bundle-sheath are of four kinds, viz.:—(1) The true transfusion-cells which occupy the greater part of this space: these are isodiametric, and have several circular pores on each of their lignified walls; on the xylem-side of the bundle they pass gradually into (2) the pith-like transfusion-tissue, the elements of which are very long, with evident intercellular spaces, and minute pores in the thin slightly lignified walls. (3) The bast-fibres, often divided by thin septa, forming a plate below the phloem of the bundle. (4) Among the true transfusion-cells are isodiametric elements which may be called transfusion-cells with simple pores, bearing a resemblance to sieve-plates. The xylem of the vascular bundle passes over into the true transfusion-tissue by a tissue which may be called transfusion-xylem, the phloem into the transfusion-cells with simple pores by a transfusion-phloem. The author distinguishes also four types as respects the position of the transfusion cells in the vascular bundle.

Increase in thickness of the arborescent Liliaceæ.†—Dr. P. Röseler has made a study of the mode of thickening of the stem and

* Acta Univ. Lund., xxiv. (1887–8) No. 7, 58 pp. and 1 pl. See Bot. Centralbl., xxxviii. (1889) pp. 730 and 756.

† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 292–348 (4 pls.).

of the formation of the secondary vascular bundles in *Yucca*, *Dracæna*, and *Aloë*. The phenomena are the same in essential points in the three genera.

The stem of any of these plants may be divided into three regions. The central portion consists of a loose tissue in which are scattered a comparatively small number of vascular bundles, becoming more numerous towards their periphery. This portion is surrounded by a usually annular zone, sharply differentiated and of closer and firmer structure, in which are a much larger number of vascular bundles; these are usually arranged in concentric circles, giving the impression of the annual rings of a dicotyledonous stem; and they are even traversed by radial striæ resembling the medullary rays; these are in connection with the leaf-traces in the central cylinder. The outermost zone, the cortex, is again composed of loose tissue, and is bounded on the outside by a more or less developed layer of cork. This annular woody zone continues to increase in thickness below, gradually disappearing towards the summit, so that the entire mass resembles a truncated cone, the result of a secondary increase in thickness, and surrounded by a zone of meristem from which are formed new parenchyme and vascular bundles. The leaf-trace-bundles bend out from the central cylinder to the cortex. In each bundle the phloem lies towards the centre of the stem, and is half surrounded by the annular and spiral vessels imbedded in parenchyme; and these are sometimes accompanied by tracheides. In the leaf-trace-bundles the true vessels gradually disappear. The secondary vascular bundles of the cone contain only tracheides and parenchyme, never true vessels.

The segments of the initial cells from which the thickening-ring originates do not appear to divide in accordance with any general law; nor do they form a ring, as in Dicotyledons and Gymnosperms. The multiplication of the thickening-rings also does not take place in the same way; and the divisions in the thickening-ring cannot be traced back to initial cells, i. e. to cambium-mother-cells which are capable of dividing without limit, forming alternately wood and cortex.

With regard to the development of the secondary bundles, the author does not agree with Kny that the tracheides are the result of the coalescence of cells; but, on the contrary, he believes that they can originate in no other way than from the development of single cells in the rudiments of the bundles.

Primary Cortex in Dicotyledons.*— According to Herr Tedin, a cork-layer is usually formed during the first year in woody Dicotyledons, either in the epiderm or in that portion of the primary cortex next the epiderm; less often in the inner portion of this tissue, or in the bast. When the cork-layer has an outer position, the cortical tissue or primary cortex is usually more strongly developed, and has thicker walls, than when it occupies a more central position; the first case presenting a resemblance to those plants which do not form cork during the first year. When the cork-layer has a more internal position, the primary cortex has usually ceased to be a living tissue at the close of the period of growth, when it splits and peels off. When the cork-layer has a more external position, or is wholly wanting during the first

* SB. Bot. Ver. Lund, Feb. 25, 1888. See Bot. Centralbl., xxxvii. (1889) pp. 300 and 380, and xxxviii. (1889) p. 727.

year, the outer cortex usually forms a collenchymatous hypodermal layer, which is not the case where the cork-layer is more internal, or at least not to the same extent. In *Ulmus* and *Tilia* the inner cortex contains mucilage.

The various special modes of development of the primary cortex are then classified under 10 different heads. In the first 6 the primary bark consists of two and only two distinct layers. In the first 5 of these the outer layer is distinctly collenchymatous. Of these again two types have a homogeneous inner layer (*Sorbus*, *Cratægus*, *Syringa vulgaris*, *Viburnum Lantana*, species of *Rosa*, most Salicaceæ and Betulaceæ, and others), while in 3 the inner bark is heterogeneous (*Ulmus montana*, *Tilia*, Cupuliferæ, *Juglans*). In the sixth type the outer cortex is not distinctly collenchymatous (*Vaccinium vitis-idæa*, *Azalea procumbens*, &c.). In the seventh the primary cortex is differentiated into more than two layers (*Leycesteria*). In the eighth it is differentiated into two layers only in certain longitudinal strips (*Viburnum Opulus*, *Cornus sanguinea*, *Forsythia*, &c.); while in the remaining two there is no distinct differentiation into more than one layer (*Rhamnus cathartica*, *Prunus spinosa*, *Hippophae rhamnoides*, &c.).

Pericycle.*—M. A. de Wevre states that before Van Tieghem the pericycle was known under the name of pericambium or rhizogenous layer. In the root the first indication of the pericycle was given by von Mohl in 1831. Generally the pericycle is formed of a single layer of cells (*Ranunculus*, *Veratrum*, &c.), less often of two layers (*Vanilla planifolia*), or it may be of a larger number of cells (five to six in *Cynodon Dactylon*). It is said to be homogeneous when all the cells are similar, and heterogeneous when it is composed of cells of various kinds, as in Araliaceæ, Umbelliferæ, and Pittosporeæ. The heterogeneous pericycle is most commonly met with. The author then points out various modifications which the pericycle may undergo, and concludes by stating that, in general terms, the root and the stem may be said to be composed of three principal zones:—(1) The cortex, comprising all the tissues up to the endoderm; (2) the pericycle; (3) the central cylinder, composed of pith, wood, cambium, and liber. In the root a portion of the secondary central cylinder is sometimes formed by the pericycle.

Mechanical System in the Roots of Aquatic Plants.†—M. C. Sauvageau states that M. L. Olivier in 1881 established that in Monocotyledons the endoderm and peripheral membrane of the central cylinder are capable of thickening; the thickening being a protection to the liber-bundles.

The central cylinder of the root of *Naias major* is composed of one or two axile vessels, representing the xylem, surrounded by a variable number of sieve-tubes of pericyclic origin separated from the central bundle by conjunctive cells. No element of this central cylinder is ever lignified or suberized, all the walls remain white, and iodine and sulphuric acid colour all the cells blue. The radial walls of the endoderm display elegant foldings. In the piliferous layer of the root the piliferous cells alternate regularly with cells which do not produce hairs; the hairs have ultimately a singular collar near their base.

The central cylinder of the root of *Naias minor* is somewhat simpler

* CR. Soc. Bot. Belg., 1889, pp. 41–7.

† Journ. de Bot. (Morot), iii. (1889) pp. 3–11, 61–72, 169–81 (19 figs.).

than that of *N. major*. Here there are one or two axile vessels separated from the endoderm by a single row of cells in which are 3–4 sieve-tubes. The central cylinder of the root of *N. minor* and of *N. major* is therefore but very slightly lignified, and corresponds to a single bundle with an axile vessel representing the xylem and peripheric phloem.

The author then describes the structure of the root of several species of *Potamogeton*. In *P. natans* not only can the endoderm thicken its cells either on their outer or on their internal and radial faces, but the permeable places are frequently wanting. All the elements of the central cylinder are susceptible of thickening or lignifying, the sieve-tubes only being an exception. Every species of *Potamogeton* studied by the author possessed true vessels, and several possessed sclerenchymatous tissue to a greater or less extent. When the sclerenchyme was feeble, it showed in the endodermal cells opposite the liber.

M. Sauvageau next describes the mechanical system in the roots of *Zostera*, *Cymodocea*, and *Posidonia*. The anatomy of these plants differs very considerably, *Zostera* and *Cymodocea* possessing no lignified elements in their roots, while *Posidonia Caulini*, which is deeply submerged, possesses on the contrary a ligneous conducting system and an important sclerotized mechanical system, which renders the root hard, and gives to it a considerable power of fixation. Comparative anatomy has shown that aerial roots when they become subterranean, or subterranean roots when they become submerged in water, lose either in part or altogether the property of thickening, and especially of lignifying their cell-walls; but this conclusion is due in certain cases to a sickly condition of the roots, which is a result of their existence in a different medium from that for which they were adapted.

Comparative Anatomy of the Aristolochiaceæ.*—Dr. H. Solereder describes the various points of anatomical structure in this order, especially in relation to the leaves, the vascular bundles, the fruit, and the seeds. Secretion-cells occur throughout the order, and in almost all the species they are found in the lamina of the leaf, in the epidermal tissue as well as in the mesophyll. They may occur in the epiderm of both surfaces, or in that of the under surface only; their walls are very often suberized; their contents are in the form of yellowish or whitish drops. When occurring in the leaf, they are to be found also in the flower. The pollen-grains are always spherical, with neither fissures nor pores.

Structure of Apocynaceæ.†—According to M. Garcin, plants belonging to this order are characterized by the presence of a double liber in the stem, an outer and an inner portion, and by the occurrence of unseptated laticiferous tubes, and of a pericycle inclosing bundles of fibres with thick walls composed of cellulose. The same essential characteristics occur also in the Asclepiadeæ.

Anatomy of Dioscoreaceæ.‡—From the examination of a number of species belonging to this order, Herr J. R. Jungner describes the

* Engler's Bot. Jahrb., x. (1888–9) pp. 410–524 (3 pls.). See Bot. Centralbl., xxxviii. (1889) p. 855.

† Ann. Soc. Bot. Lyon, xv. See Morot's Journ. de Bot., Rev. Bibl., iii. (1889) p. xliii.

‡ Bih. K. Svensk. Vet.-Akad. Handl., xiii. (1888) Afd. 3, No. 7. See Bot. Centralbl., xxxviii. (1889) pp. 734 and 760.

peculiarities of structure in the following points :—General differentiation of the tissues ; epidermal tissues ; fundamental tissue ; vascular bundles, with respect to their course, the various tissues of which they are composed, and the structure of their elements. He considers that the most important characters in the differentiation are to be derived from the epidermal tissue. The various points of structure are described in great detail.

Fibres and Raphides in Monstera.*—Mr. W. S. Windle describes the presence in the exocarp or inedible portion of the fruit of *Monstera deliciosa* not only of raphides, but also of slender, sharp-pointed, needle-like cells or fibres, apparently half-imbedded in the large-celled parenchymatous tissue. It is these chiefly which cause the sharp stinging sensation in the tongue and palate when this outer coating of the fruit is taken into the mouth.

(4) Structure of Organs.

Obdiplostemonous Flowers.†—By this term Herr K. Schumann understands those flowers in which there are two whorls of stamens, and the carpids are opposite the members of the outer whorl. This structure occurs in many orders of Apopetalæ ; among Gamopetalæ only in the Bicornes (Rubiaceæ, &c.) ; in Monocotyledones it is unknown. From the numerous cases observed by the author he holds that the law of alternation of members of adjacent whorls has been too absolutely laid down by morphologists ; it is broken through where the members of the preceding whorl are very small, or when they are of cap-like form. This is also the case with regard to the law of acropetal succession in the development of the different organs of the flower, which may be interrupted by the interposition of members of additional whorls. He regards contact alone as sufficient to determine the position of the carpids in isomerous flowers, and in others also in which abortion has taken place of members of particular whorls.

Pollen-grains.‡—Prof. B. D. Halsted points out that pollen-grains frequently alter their shape greatly when wetted. Oval grains may increase as much as 33·2 per cent. in their shorter diameter, while shrinking 12·2 per cent. in their longer diameter. Many grains have characteristic folds which are lost when the grain is wetted. The pores are not usually so evident in the dry pollen as when it is wet. For full and perfect representation of a pollen-grain it should be measured twice ; when dry, that is, in the condition to pass from the anther to the stigma, and again when fully swollen by the imbibition of water. The largest diameter measured was 130–138 μ, in *Œnothera biennis*.

Form of Pollen-grains.§—According to Herr F. Tschernich, the morphological structure of the pollen-grain is sometimes uniform throughout entire orders, as in the Coniferæ, Gramineæ, Compositæ, and Caryophyllaceæ. In other cases it can be used to determine the genus, as in *Salix* and *Populus* among Salicaceæ, *Euphorbia*, *Buxus*, and *Croton*

* Bot. Gazette, xiv. (1889) pp. 67–9 (1 pl.).
† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 349–426 (1 pl.).
‡ Bull. Torrey Bot. Club, xvi. (1889) pp. 135–6.
§ 'Ueb. d. Bedeutung d. Pollens f. d. Charakteristik d. Pflanzen,' 1888. See Bot. Centralbl., xxxviii. (1889) p. 833.

among Euphorbiaceæ. Occasionally it is of systematic value even within the genus, as in the various species of *Pyrola*.

Nectarial Scales of Ranunculus.*—Herr S. Almquist describes an abnormal specimen of *Ranunculus aconitifolius*, in which the outer margin of the honey-gland on each petal had developed into a petal-like structure. He draws the conclusion that the original form of the honey-gland is that of the subgenus *Batrachium*, and of *R. sceleratus*, viz. an open hollow pit, from which all the other forms found in the genus are derived.

Structure of the Bracts and Bracteoles in the Involucre of Corymbiferæ.†—M. L. Daniel describes the anatomical structure of the bracts and bracteoles in various genera of Corymbiferæ. The author points to *Buphthalmum salicifolium* as the most differentiated of the Corymbiferæ, the bracteole possessing two bands, while in *Gnaphalium*, *Antennaria*, *Filago*, &c., there is only one band.

Development of Berry-like and Fleshy Fruits.‡—Herr J. Bordzilowski describes the development of a large number of fruits of different kinds. The course of the vascular bundles in the carpels is always the same as in the leaves; i. e. there are a median and two marginal bundles; and if the ovary consists of several carpels, each pair of marginal bundles may coalesce. When the ovary is superior and monocarpellary, there is only a single ring of bundles; if it consists of more than one carpel, there may be two rings. In inferior ovaries the bundles belonging to the calyx-tube form an independent ring. The development of a fleshy fruit from an ovary takes place in different ways; this is indicated in the cases of the drupe, the berry of *Ampelopsis* and *Sambucus*, the apple, and the cucumber.

Septated Vittæ of Umbelliferæ.§—Herr A. Meyer describes the vittæ or oil-receptacles which are almost universally found in the pericarp of ripe fruits of Umbelliferæ as being clothed with a peculiar layer, which is itself protected by a special cuticle-like membrane which completely covers the outer surface of the epithele, the whole forming a sac inclosing the special secretion. In only a few species (*Coriandrum sativum*, *Lagœcia cuminoides*) is this sac entirely unseptated; in a few others (*Heracleum Sphondylium* and *caucasicum*, *Sison Amomum*, *Æthusa cynapium*) it is imperfectly septated; in the great majority of umbellifers the sac and the layer are divided into a number of chambers. The layer itself consists of a peculiar substance, the exact nature of which is not yet determined; but it is neither a carbohydrate, a fatty oil, a mixture of these, a resin, nor a caoutchouc-like substance, as is shown by its microchemical reactions. In some species, between the thick septa and the parietal layer is a ring of irregular thick-walled vacuoles. In *Conium maculatum*, where the vittæ are only rudimentary in the ripe fruit, the peculiar layer is wanting. In one species only, where the vittæ are well developed, *Johrenia græca*, is the aromatic secretion altogether wanting, and replaced by a solid substance. In *Astrantia major*

* Bot. Sällsk. Stockholm, March 21, 1888. See Bot. Centralbl., xxxviii. (1889) p. 662.

† Bull. Soc. Bot. France, xxxvi. (1889) pp. 82–5.

‡ Arb. Kiew. Naturf. Gesell., ix. (1888) pp. 65–106 (2 pls.). See Bot. Centralbl., xxxviii. (1889) p. 792.

§ Bot. Ztg., xlvii. (1889) pp. 341–52, 357–66, 373–9 (1 pl. and 1 fig.).

and *Eryngium maritimum*, where the fruit is but slightly aromatic, the vittæ have no layer, but instead a fluid secretion.

At a very early period in the formation of the vittæ, even in the flower-bud, substances of two different kinds are exuded from the walls of the epithelial cells into the vitta, viz. a watery fluid and an ethereal oil insoluble in water. The vittæ themselves are always of schizogenous origin. The object of the layer above described is clearly to retain the secretion in the vitta and to prevent its flowing into the surrounding tissue. The anise oil contained in the vittæ of *Fœniculum officinale* and *Pimpinella Anisum* and the caruol in those of *Anethum graveolens* and *Carum Carui* are highly poisonous to birds.

Fruit of Grasses.*—M. H. Jumelle is unable to accept the ordinary view of the structure of the caryopsis of the Gramineæ, that it is a fruit in which there is complete fusion of the integument of the ovule with the pericarp. He finds no evidence of such a fusion taking place at any time, but, on the contrary, the pericarp is partly absorbed during maturation, and the integuments of the seed completely disappear. The caryopsis is, in fact, an ordinary achene inclosing a single seed without integuments.

Primula with Anatropous Seeds.†—M. A. Franchet states that one point of difference between the genera *Hottonia* and *Primula* is that in the former the seeds are anatropous, while they are hemitropous in the latter. He then describes two *Primulas*, *P. Delavayi* and *P. vinciflora* from China, having anatropous seeds as in *Hottonia*. The anatropy of the seeds is only complete at maturity. In the ovule and young seed hemitropy is still evident, especially in *P. Delavayi*. If the ripe seeds of *Hottonia* are compared with those of these two *Primulas*, it is readily seen that anatropy exists to the same degree, and is present under the same conditions in the two genera.

Seed of Victoria.‡—In pursuance of his researches on the structure of the Nymphæaceæ, Prof. G. Arcangeli has now carefully examined that of the seeds of *Victoria regia*. He finds an outer integument and an inner much thinner one, closely adpressed to the seed. The seed itself consists of three parts, embryo, endosperm (albumen), and perisperm; and, as in *Euryale*, *Nymphæa*, and *Nuphar*, the amylaceous reserve-material is found chiefly in the perisperm, which is much the most developed of the three, while the albuminoid and fatty reserve-materials abound in the embryo, although an albuminoid network is also present in the perisperm, inclosing the grains of starch.

Borragoid Inflorescence.§—Herr K. Schumann compares the peculiar inflorescence, to which he gives the term *borragoid*, characteristic of the Borragineæ, Hydrophyllaceæ, Solanaceæ, and some Labiatæ, with the true cyme, such as obtains in *Ru'a* and *Echeveria*, and finds the difference not so great as has been maintained by some writers. The dorsiventral structure occurs also in true cymes. The borragoid is only a special case of the true cyme, the determining factor of which is the dichotomous division of the cone of growth, in contrast to the lateral

* Comptes Rendus, cvii. (1888) pp. 285-7.
† Journ. de Bot. (Morot), iii. (1889) pp. 49-52 (3 figs.).
‡ Nuov. Giorn. Bot. Ital., xxi. (1889) pp. 286-9. Cf. this Journal, *ante*, p. 407.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 52-80 (1 pl.).

branching of the true cyme. This is especially seen from an examination of the double borragoid, like that of *Cerinthe*.

Leaf of Taxodium.*—Prof. S. Coulter finds the leaf of *Taxodium distichum* to differ from that of *Pinus sylvestris* (agreeing rather with the young leaves of *Pinus*) in the following points:—(1) In the less perfect development of the stomates; (2) in the imperfect development and indefinite arrangement of the strengthening apparatus, shown by the absence of the continuous hypodermal layer and the absence of sclerenchyme from the region of the resin-duct; (3) in the presence of a single resin-duct, showing imperfect differentiation from the surrounding tissue; and (4) in the less complete development of the vascular bundle and of its elements.

Origin of Rootlets.†—In a very elaborate paper on this subject, MM. P. Van Tieghem and H. Douliot state that for the origin of rootlets in Phanerogams, one general and very simple rule may be given. In all Phanerogams the rootlets proceed from a transverse growth localized in the pericycle of the mother-root, and their three regions are cut off in the same manner by two tangential divisions in the group of pericyclic cells which gather together radially. The position of the lateral root varies; it may be situated either opposite the phloem of a vascular bundle, or opposite a ray, or it may either be placed in the middle of a ray and inserted at the same time on two neighbouring vascular bundles, or laterally and inserted only on the side of the corresponding bundle.

The existence or absence of a pocket, and its thickness, origin, and mode of separation, are characters which modify the external aspect of the rootlet, but are quite subordinate characters, seeing that they vary not only in allied families, but also in allied genera belonging to the same family, and sometimes from one species to another in the same genus, and occasionally from one root to another in the same plant. Two distinct variations, however, can be traced in the mode of formation of pockets in Phanerogams: either the desquamation of the epiderm is partial, as in Dicotyledons (except Nymphæaceæ) and Gymnosperms, or the desquamation is total, as in Monocotyledons and Nymphæaceæ.

The authors then describe the origin and development of lateral roots in Vascular Cryptogams, and state that in this latter group of plants two great divisions can be recognized, the one comprising the Filicineæ, and the other *Lycopodium* and *Isoetes*. In the first division the root is formed in the innermost layer of the cortex, that is, in the actual endoderm. Filicineæ are, therefore, endodermorhizal and monacrorhizal. In the second division the root is formed in the outermost layer of the central cylinder, that is, in the pericycle; *Lycopodium* and *Isoetes* are, therefore, pericyclorhizal and triacrorhizal.

If we compare these two groups with Phanerogams, it will be seen that the second resembles them in all points, while the first differs precisely to the same extent as it differs from the second. There are then two types of formation and growth of roots in vascular plants. If we divide Vascular Plants into two great groups, the first would include Phanerogams, *Lycopodium*, and *Isoetes*; while the second would include all Vascular Cryptogams, with the exception of *Lycopodium* and *Isoetes*.

The authors conclude this exceedingly lengthy paper by describing

* Bot. Gazette, xiv. (1889) pp. 76–81, 101–7 (1 pl. and 1 fig.).
† Ann. Sci. Nat., viii. (1888–9) pp. 1–660 (40 pls.).

the origin, internal growth, and development of the other endogenous members, the general conclusions being that in Phanerogams the rootlets, lateral roots, and terminal roots or buds all originate in the pericycle, while in Vascular Cryptogams they originate in the endoderm.

Composition of the Tubercles of Stachys tuberifera.*—M. A. Planta states that the tubercles formed on the swollen internodes of the subterranean branches of *Stachys tuberifera* are peculiarly interesting on account of their chemical composition. The following is the analysis:—

	Fresh.	Dry.
Water	78·33	—
Proteïds	1·50	6·68
Amides	1·67	7·71
Fat	0·18	0·82
Carbohydrates	16·57	76·71
Cellulose	0·73	3·38
Ash	1·02	4·70
	100·00	100·00

The tubercles contain therefore 21·67 per cent. of dry substance, the most important being the carbohydrates, the principal of which is a new substance, intermediate between starch and sugar, which he calls *galactane*.

Origin of the Haustoria in Parasitic Phanerogams.†—M. Granel states that in none of the parasitic Phanerogams which he has studied does the piliferous layer contribute to the formation of the haustorium, but that this organ originates more deeply in the cortical parenchyme. The tissues thus formed join themselves more or less slowly to the endoderm and to the pericycle, which in their turn divide in order to attach the central cylinder to the vascular structures of the haustorium. In stem-parasites (*Cuscuta*) the progress of the development is just the same. The morphological nature of these haustoria has been much discussed, and for long they were grouped with lateral roots or rootlets. The author, however, states that their origin is totally different. They are from the first exogenous formations, and afterwards unite with structures proceeding from the endoderm and pericycle.

Criticizing this paper, M. Leclerc du Sablon ‡ states that M. Granel has studied, not the development of the haustoria, but certain definite forms, which are presented in roots of various ages, of haustoria in which the growth has been more or less abortive.

Haustoria of Rhinanthaceæ.§—Herr L. Koch has closely followed out the germination and development of *Rhinanthus minor*. He finds that the seeds germinate freely, but very slowly, and only in the spring. If the seedlings do not encounter a suitable host-plant they soon perish, unless a large number grow close together, when they put out a number of haustoria into one another, and develope to the flowering stage, but

* Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 85–7 (1 fig.).
† Journ. de Bot. (Morot), iii. (1889) pp. 149–53 (1 pl.).
‡ T. c., pp. 183–4.
§ Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 1–37 (1 pl.). Cf. this Journal, 1888, p. 80.

only in a weakly condition. They grow vigorously only when they meet with host-plants, especially grasses.

The roots of *Rhinanthus* are but very sparsely supplied with root-hairs, and consequently have but little power of independent nutrition. The haustoria are formed at an early period, and are, like those of *Melampyrum*, exogenous. They penetrate the root of the host by means of a sac-like cell not unlike the apical cell of a growing-point, which breaks through the endoderm of the vascular bundle of the host and enters the thick-walled xylem, probably with the aid of a solvent excretion. The process is somewhat different according as the host-plant is a monocotyledon or dicotyledon. The haustoria contain no starch, but, on the other hand, minute granular or rod-like albuminous bodies, which gradually fill up the tissue, but are used up by the time of flowering, and closely resemble the "bacteroids" of the tubercles of the roots of Leguminosæ.

Rhinanthus is, therefore, in contradistinction to *Melampyrum*, a true parasite; but it may also live to a certain extent saprophytically. The cells of the parasite are in contact with a homogeneous yellow mass resulting from the decomposition of the cells of the host; the vascular bundles of the host being also to a large extent destroyed. From the margin of the haustorium cells also advance towards and penetrate the cortex of the host and destroy it, applying themselves to and embracing the destroyed portion somewhat in the manner of root-hairs. Parasitism is, therefore, necessary for the vigorous growth of *Rhinanthus*, but the plant is, like the mistletoe, only a partial parasite, carrying on an independent assimilation of its own, and not inflicting any serious injury on the host.

M. Granel * dissents to a certain extent from the observations of Leclerc du Sablon and Koch on the origin of the haustoria in *Melampyrum* and *Rhinanthus*, inasmuch as he asserts that they do not spring from the piliferous layer, but, in accordance with his previous observations on *Orobanche* and the Santalaceæ, from the cortical parenchyme. He agrees, however, with those authorities as to the morphological nature of these organs. They are of exogenous origin, not springing, like the rootlets, from the pericycle, and they do not present the least trace of root-cap; the arrangement of their vascular system is also very different from that of roots.

Modifications in the Roots of Grasses growing in Water.†—M. Devaux describes certain modifications which had taken place in the roots of *Lolium* and *Holcus mollis* when grown in water. In *Lolium* the development of the roots at first appeared normal; but, after having attained a length of some centimetres, a large number were observed in which the growing point, instead of continuing its descending direction, inclined towards the side, then raised itself, and finally followed a helicoid line of growth in the liquid. In *Holcus mollis* the root-hairs preserved their normal form, but a number of tubercles were developed, the radicles being arrested in their development.

* Comptes Rendus, cviii. (1889) pp. 367–9.
† Bull. Soc. Bot. France, xxxvi. (1889) pp. 76–81.

β. Physiology.*

(1) Reproduction and Germination.

Diclinism and Hermaphroditism.†—Starting from an examination of the phenomena of reproduction in *Limnobium stoloniferum* (Hydrocharideæ), Herr U. Dammer concludes that the original condition in flowering plants is that of monœcism, from which diœcism and hermaphroditism have been derived, and that the highest conceivable condition is where heterostyled dichogamous hermaphrodite are densely aggregated along with diclinous flowers, such as we find in the capitula of Compositæ; pollination being here secured, but self-fertilization prevented. This order he regards, therefore, as the highest existing form of Dicotyledons, and the Orchideæ of Monocotyledons, while the Hydrocharideæ, in which hermaphroditism is very rare, represents one of the oldest branches of the latter group. A detailed description follows of the anatomy, morphology, and biology of the species named.

Trimorphism of Oxalis.‡—Mr. W. G. Eliot and Prof. W. Trelease give a series of measurements of the length of style and filaments in the three forms of the American trimorphic species of *Oxalis*. They regard trimorphism as a device for surer and more abundant cross-fertilization. The relative number of long-styled, short-styled, and mid-styled forms observed was about in the proportion of four, five, and eleven.

Pollination by Lepidoptera.§—Sig. G. E. Mattei describes the adaptation of the proboscis of lepidoptera for obtaining the honey of flowers; and of the flowers themselves for receiving the visits of the insects. He enumerates 132 sphingophilous species, characterized by blossoming in the evening or night; by their strong odour, especially at night; white or yellowish colour; long, slender, often curved tubular corolla or spur, yielding abundance of honey; viscid or united pollen-grains; and by their usually projecting stigma and stamens, often with very motile filaments.

Perforation of Flowers by Insects.‖—Mr. L. H. Pammel, after describing the mode of fertilization of *Phlomis tuberosa*, enumerates the instances in which the corolla of flowers is known to be perforated by insects or birds in order to obtain the nectar. The insects with which this is habitual are mostly species of *Bombus*, the hive-bee most commonly making use of perforations already made by other insects. The tendency is to produce sterility by preventing pollination in the ordinary way, though this is by no means always the case. The perforation of the corolla is usually attributable to the non-adaptability of the insect to the flower, and the insect often uses considerable ingenuity in perforating the flower, attacking it in close proximity to the nectary. This is individual and not inherited experience on the part of the insects. *Phlomis tuberosa* and *Symphytum officinale* are examples of flowers which are abundantly perforated, and are yet very productive.

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

† 'Beitr. z. Kennt. d. veget. Organen v. *Limnobium stoloniferum* Griseb., nebst einigen Betrachtungen üb. d. phylogenetische Dignität v. Diclinie u. Hermaphroditismus,' 17 pp., Berlin, 1888. See Bot. Centralbl., xxxviii. (1889) p. 743.

‡ Trans. Acad. Sci. St. Louis, v. (1888) pp. 278–91 (3 figs.).

§ 'I lepidotterie e la dicogamia,' Bologna, 1888, 48 pp. See Bot. Centralbl., xxxviii. (1889) p. 792. ‖ Trans. Acad. Sci. St. Louis, v. (1888) pp. 241–77 (2 pls.).

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

Development of Annual Plants.*—M. H. Jumelle describes the variations which the different members of an annual plant undergo according to their age, and to the external conditions to which they are subjected. From germination to maturity five principal periods may be distinguished. In the first, or germinating period, there is a simple migration of matter from the cotyledons towards the hypocotyledonary parts, and the plant not only does not assimilate, but loses some of its dry weight by chemical transformations. In the second period assimilation commences. The cotyledons lose a further portion of their substances to the hypocotyledonary, and also to the epicotyledonary parts which now begin to develope. The third period is marked by the disappearance of the cotyledons, and there is a rapid transportation of substance from the hypocotyledonary axis towards the summit of the plant. In the fourth period the flowers appear, and a fresh migration of matter takes place towards the summit of the plant. The fifth period commences after flowering. There is a considerable increase in dry weight in the root, stem, and leaves; and the absorption of mineral matter is very active. The quantity of water follows less rapidly and in different proportions these variations of dry substance. In the cotyledons, on the contrary, it tends to augment while the dry material diminishes.

Influence of External Agents on the Polarity and Dorsiventral Structure of Plants.†—M. Kolderup Rosenvinge in the first place describes various experiments made with the spores of the Fucaceæ, in order to determine the influence of external agents on polarity. The following are the most important conclusions:—(1) The polarity of the spores which germinated (that is, the determination of the point where the rhizoids and the apical point appeared) can be determined by diverse external agencies; (2) Light may influence the orientation of the first septum; (3) Light determined the polarity of the plants in all the species studied except *Fucus serratus*. The sensibility to light was greatest in *Pelvetia canaliculata*; (4) Gravitation had no influence on the polarity of the plants; (5) Contact with a solid body had no influence on the polarity of the plants; (6) A difference in the quantity of oxygen on the different sides of the spores affected the polarity, rhizoids forming on the side where the oxygen was most feeble; (7) In all the species the polarity could be determined exclusively by internal causes, which seemed independent of the orientation of the oosphere in the oogone.

In the second part of the paper the author discusses the dorsiventral structure of plants. It is well known that dorsiventral organs are ordinarily plagiotropic; nevertheless shoots have been found in *Vicia Faba* and several species of *Begonia*, which grow vertically, although they have a pronounced dorsiventral structure. *Centradenia floribunda* furnishes an example of a dorsiventral structure which is produced by an external influence, and which can be reversed by inverse action of the cause which produced it. In none of the other plants studied could the

* Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 101–22, 195–211, 258–79, 318–29; and Bull. Soc. Bot. France, xxxvi. (1889) pp. 72–6.

† Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 53–63, 123–35, 170–4, 244–55, 304–17 (19 figs.).

dorsiventrality be reversed. In certain plants the orientation of the dorsiventral structure of lateral branches can be determined by external agencies (ex. *Columnea Schiedeana*, *Scutellaria albida*). Often, however, it is independent of external agencies, and is determined solely by the mother-axis. In certain plants the lateral branches are dorsiventral, the primary axis remaining radial (ex. *Callisia delicatula*, *Cyanotis cristata*); more often, however, the primary axis itself becomes dorsiventral sooner or later. In all the plants studied in which the primary axis became dorsiventral, except *Cicer arietinum*, the dorsiventral structure of this axis could be determined by light or gravitation. When the dorsiventral structure is determined by light, the illuminated surface usually becomes superior, and in normal conditions faces upwards.

One-sided Hardness of Wood.*—According to Herr P. Kononczuk, it is especially common in conifers for the annual rings to be very much thicker on one side of the branch or stem than on the other side; and the wood is then harder on that side where the rings are broadest. In the case of horizontal or oblique stems or branches, this is always the case on the under side, and is due to gravitation; in the case of erect stems, it is found on that side which produces the greatest number of branches, i. e. that one most exposed to the air, or especially on the east or south side.

Influence of Exposure on the Growth of the Bark of Conifers.†—From the result of a large number of observations, M. E. Mer finds that in pine-trees the sides most exposed to the heat of the sun, i. e. the south and west, have a thicker bark relatively to the thickness of the wood than those not so fully exposed. Exposure to heat and light retard the formation of wood relatively to that of the bark.

Chlorophyllous Assimilation and Transpiration.‡—M. H. Jumelle describes certain experiments made with the object of ascertaining whether there exists any relation between the two phenomena of chlorophyllous assimilation and transpiration; in other words, whether, if one of them is arrested the other is modified. The conclusions of the author are that the presence of carbon dioxide in the air, or the presence of potash, which might accelerate the transpiration by drying the air, has really no sensible effect on transpiration; but that if the function of the chlorophyll persists while assimilation is suspended, the intensity of the transpiration is augmented. This accords with the theory of Weisner, who maintains that a portion only of the light which traverses the chlorophyll takes part in the decomposition of the carbon dioxide, the heat provided by the other portion producing the transpiration; that is, if assimilation is suppressed, that portion of the luminous ray which serves for the decomposition of the carbon dioxide remains free. The result is that more heat is developed, and consequently a larger amount of transpiration takes place.

Influence of Mineral Substances on the Growth of Plants.§—By contrasting the development of plants (chiefly lupins) grown in distilled

* Jahrb. St. Petersb. Forstinstit., ii. (1888) pp. 41–56 (4 pls.). See Bot. Centralbl., xxxviii. (1889) p. 794.

† Journ. de Bot. (Morot), iii. (1889) pp. 52–9, 77–83, 106–12, 114–21, 136–40. Cf. this Journal, 1888, p. 762.

‡ Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 37–46.

§ Comptes Rendus, cviii. (1889) pp. 466–8.

water with those grown in ordinary soil, M. H. Jumelle comes to the conclusion that the presence of mineral substances favours the production of parenchyme rather than that of supporting tissue. During the earliest stages of development no difference could be detected in the development of the sets of plants grown under different conditions; but after about 60 days, when the number of leaves exceeds five or six, in the former set the leaves were found to be small and bright green, the internodes long and slender; in the latter the leaves were large and yellowish-green, the internodes short and thick. The difference appears to be due less to the absence of the salts themselves than to the accompanying diminution of the water of constitution.

Trophilegic Function of Leaves.*—Prof. G. Arcangeli calls attention to the observations of Goebel † on the heterophylly of the leaves of tropical species of *Platycerium* and other ferns. He points out that the presence of leaves of a shell-like form is not peculiar to ferns, but occurs also in many flowering plants; the function of these leaves being, if not the direct absorption of water, the collection of food-material for the use of the plant. He proposes for this function, to which he thinks too little attention has been paid, the term *trophilegic*.

Movement of Sap in the Wood.‡—According to Prof. R. Hartig, the movement of fluid in woody stems takes place chiefly in the outer layers of alburnum, the inner layers of alburnum forming a reservoir where it is stored up when not in motion. In Coniferæ the tracheides together with the medullary rays are certainly the organs of conduction from one layer to another; while in Dicotyledons it is probably the vessels in which this movement of the sap takes place. The vessels, which diminish the weight of the wood by their size and by the thinness of their walls, run downwards from the leaves through the corresponding annual ring to the root. In a beech 143 years old the number of vessels in the youngest annual ring was estimated at 116,000.

Dr. Hartig further replies § to Wieler's criticisms ‖ on his previously published results, repeating his reasons for coming to the conclusion above stated as to the ordinary course of the movement of fluids.

Exchange of Gases in Submerged Plants.¶—M. H. Devaux has studied, by means of a mechanical apparatus, the mechanism of the exchange in gases in plants entirely submerged, the experiments having been made chiefly on *Elodea canadensis*.

The escape of gases may take place either by diffusion through the cell-walls or in the form of bubbles; the former mode being very analogous to that which would take place across an immobile liquid plate. The entrance by diffusion takes place in the same way, whether the plant grows in air or in water. Bubbles disengaged from the interior of the plant are always the result of injury; and from an examination of these it was found that the internal atmosphere of submerged plants has very nearly the same composition as the external air,

* Nuov. Giorn. Bot. Ital, xxi. (1889) pp. 272–6.

† Cf. this Journal, 1888, p. 90.

‡ SB. Bot. Verein München, Feb. 11, 1889. See Bot. Centralbl., xxxvii. (1889) p. 418.

§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 89–94.

‖ Cf. this Journal, *ante*, p. 251.

¶ Ann. Sci. Nat. (Bot), ix. (1889) pp. 35–180.

the change produced by respiration being compensated by other changes resulting from diffusion. In addition to bubbles disengaged from intercellular spaces in the interior of the plant, there are often others, always very small, on the surface of submerged plants; these result entirely from the air dissolved in the water, and occur only on plants without intercellular spaces, especially on Algæ. The air in the intercellular spaces is subject to constant variations of pressure. These intercellular spaces are formed in the tissue at a very early period, occurring even near the extremity of the cone of growth of the stem.

As a general result, the author states that there always exists air dissolved in all the constituent parts of a submerged plant, and that the gas in every cell is subject to a uniform pressure, corresponding nearly to that of the surrounding air.

Absorption of Water by Leaves.*—In order to determine whether plants can absorb water through their leaves, Herr W. Chmielewskij arranged branches of a number of shrubs and trees, so that a portion of their leaves was immersed in water, the remainder being exposed to the air. In all cases except one, the leaves immersed in water remained fresh for a longer period than those exposed to the air. The absorption of water does not take place through the stomates, but equally through both surfaces of the leaf; the stomates remained filled with air.

Changes of Substance and Force connected with Respiration.†—Pursuing his investigations on this subject, Dr. H. Rodewald again finds the average value of the relationship $\frac{CO_2}{O_2}$ to be very near unity. In the case of the cabbage, which was especially the subject of investigation, the author believes deviations from this average to be due to other chemical processes going on side by side with that of respiration. An absorption of energy must necessarily take place in the conversion of cellulose or phellogen into grape-sugar, since the heat evolved in combustion is greater in the case of cellulose than in that of grape-sugar. The same must be the case when grape-sugar is converted into starch, and possibly also in the splitting up of albuminoids.

γ. General.

Chlorosis.‡—The disease of chlorosis, characterized by the pale yellow colour of the leaves and the stunting of the branches, which is very destructive to vineyards, is attributed by M. E. Petit to an excess of moisture in the soil, filling the cavities which ought to be full of air. It is, in fact, the outward manifestation of the choking of the roots. Various remedies are discussed.

Vuillemin's Vegetable Biology.§—This work is divided into three parts:—The life of the cell; the life of the individual; and the social life of plants. The first chapter is devoted to the cell in general. The cell is formed by two kinds of microsomes, cytosomes and caryosomes,

* Arb. Neu-russ. Naturf. Gesell., xiii. (1888) pp. 123–34. See Bot. Centralbl., xxxviii. (1889) p. 790.

† Jahrb. f. Wiss. Bot. (Pringsheim), xx. (1889) pp. 261–91. Cf. this Journal, 1888, p. 771.

‡ 'La chlorose: Rech. d. ses causes et d. ses remèdes,' Bordeaux, 1888. See Bull. Soc. Bot. France, xxxvi. (1889), Rev. Bibl., p. 84.

§ 'La Biologie végétale,' 16mo, Paris, 1888, 360 pp. and 82 figs.

generally localized in two distinct regions, and constituting the cytoplasm and the caryoplasm or nucleus. On contact with a foreign body the cytoplasm takes on itself special characters, and becomes a dermatoplasm or membranous layer. Cytodes are elements in which the caryosomes are not grouped into a nucleus. The cell-membrane is regarded by the author as always an intracellular derivative.

The thallus springs from an isolated cell or spore. The body of fungi is generally formed of cells reduced either to nucleus or to cell-wall; this structure is not properly non-cellular; the author terms it *apocyty*. A more highly organized type is the result of fecundation. The elements of the embryo are differentiated from the first into an epithele or epiderm and an apothelial mass. The epithelial body, represented in mosses by the sporogone, is the point of departure of the vascular body of the higher plants. Certain aberrant types of vascular cryptogams, such as ferns, present a stage of suppressed embryo, the oosphere giving rise directly to the vascular members; this condition is termed by M. Vuillemin *apoembryony*.

In the portion of the work devoted to the life of the individual, the organs of fixation, support, and protection are first treated of, followed by the phenomena of absorption and excretion. These two processes he regards as opposites, the latter being concerned with everything which the plant gives out to the environment, whether ponderable matter or mechanical work. The author then deals with respiration, and the functions of specific lives, which he classifies under renovation, multiplication, fusion, conservation, and dispersion.

Under the head of the social life of plants are discussed the relations between individuals of the same species, and especially the sexual relations, and finally, the relations between individuals of different species, including epiphytism, hybridity, grafting, parasitism, and symbiosis, particularly the algo-lichen theory, and the phenomenon of mycorhiza.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Psilotum and Tmesipteris.*—Dr. W. A. Haswell has carefully examined the structure of *Psilotum triquetrum* and *Tmesipteris tannensis*, natives of New South Wales.

Tmesipteris tannensis grows most commonly on the trunks of tree-ferns, deeply buried in the fibrous coating of the stem, less often creeping along the ground. The stem always branches dichotomously. It has a central bundle of small scalariform and reticulated tracheides, without any definite bundle-sheath; but is surrounded by from one to four layers of cells filled with a solid brown substance. In the leaf-bearing portion the xylem portion is central, and is surrounded by phloem. The cortical tissue is strongly sclerenchymatous in its outer part. The leaves are oval and unsymmetrical at the base, with a single unbranched mid-rib, which is produced at the extremity into a spine-like point. The sporanges are borne on special lateral branches which terminate in bracts similar to the ordinary leaves, but smaller. Each sporange has two loculi; the spores are oval and compressed.

Psilotum triquetrum is shrub-like in habit, with very minute leaves.

* Proc. Linn. Soc. N. S. Wales, ii. (1888) pp. 1025–31.

The single central vascular bundle of the stem is also concentric, and is inclosed in a bundle-sheath which is surrounded by a layer of brown tissue similar to that of *Tmesipteris*, but less strongly developed. Stomates are abundant on the stem. Each sporange contains a large number of spores.

All attempts to rear the prothallium failed in both genera.

Calamarieæ.*—Herr D. Stur gives a detailed account of the morphology of this group of Fossil Vascular Cryptogams, including their roots, rhizome, true stem, branches, and leaves. They differ from the recent Equisetaceæ, to which they are otherwise nearly allied, chiefly in the property of forming wood. The branches are also much more polymorphic than those of living *Equiseta*. The Asterophylliteæ and Annularieæ are homomorphic, the Sphenophylleæ heteromorphic branches; the homomorphic branches bore *Bruckmannia*-fructifications with microspores, the heteromorphic branches *Volkmannia*-fructifications with megaspores. Twenty-four species are described in detail, arranged under the genera *Calamites*, *Asterophyllites*, *Bruckmannia*, *Annularia*, *Cingularia*, *Volkmannia*, and *Sphenophyllum*.

Muscineæ.

Peristome.†—M. Philibert continues his studies on the peristome, and now describes the differences between the Nematodonteæ and the Arthrodonteæ, and discusses certain groups which are transitional between these two. The Tetraphideæ closely resemble the Polytrichaceæ. One important difference, however, may be found in the peristomial fibres; in the Polytrichaceæ these fibres are perfectly simple and undivided, and continue without interruption the whole length of the tooth, while in the Tetraphideæ they only occupy a portion of the length of the peristome. The author then points out how very different is the structure in these two families to that found in the Arthrodonteæ; and concludes by describing the two families Buxbaumiaceæ and Encalypteæ, which present an intermediate structure between the Nematodonteæ and the Arthrodonteæ.

Encalypta longicolla and *E. brevicolla* are especially interesting to study in order to determine the origin of the peristome. The structure of the peristome in these two species nearly approaches that in the Arthrodonteæ; and in another species, *E. apophysata*, we have a type of peristome which seems exactly intermediate between the Arthrodonteæ and Nematodonteæ. A gradual scale may be formed, beginning with *Tetraphis*, and passing first through *Encalypta longicolla*, then through the diverse forms of *E. brevicolla* and *apophysata*, and finally reaching *E. procera* and *E. streptocarpa*, where the double peristome of the Arthrodonteæ is completely developed.

Inflorescence of Orthotrichum.‡—Herr A. L. Grönwall points out that in various species of *Orthotrichum*, as, e.g. in *O. speciosum*, three different positions of the male inflorescence may occur in the same species, viz.:—Axillary, pseudo-lateral (at the base of the fertile branch), and terminal.

* 'Die Calamarieen d. Carbonflora d. Schatzlarer-Schichten,' Wien, 1887 (26 pls. and 43 figs.). See Bot. Centralbl., xxxviii. (1889) pp. 779 and 797.

† Rev. Bryol., xvi. (1889) pp. 1–9, 39–44. Cf. this Journal, *ante*, p. 257.

‡ Bot. Ver. Lund, March 27, 1888. See Bot. Centralbl., xxxviii. (1889) p. 759.

Colouring-matter of Sphagnaceæ.*—According to M. F. Gravet, the red or orange colouring-matter of the male branches and of the capsules of the different species of *Sphagnum* is caused by the presence of tannin, produced under the action of light, although the male branches are also coloured even when growing in the shade.

Algæ.

Vacuoles in Algæ.†—Herr F. A. F. C. Went describes the occurrence of vacuoles in the reproductive and propagative organs of a number of Algæ belonging to the Florideæ, Fucaceæ, Phæosporeæ, Cladophoreæ, and Codieæ. He finds them to agree with those previously observed in the vegetative organs, in the presence of a living tonoplast, and in the fact that the normal vacuoles invariably result from the division of those already in existence. The organs in which they were detected are, among others :—the sporanges of *Codium*, the zoospores of *Chætomorpha*, the sporanges of *Sporochnus*, the oogones and antherids of *Cystosira* and *Sargassum*, the tetraspores, pollinoids (spermatia), and carpospores of several Florideæ, and many others.

Antherids and Pollinoids of Florideæ.‡—M. L. Guignard continues his account of the male sexual elements in Cryptogams with a study of these organs in the Florideæ. Their structure and mode of origin are in general terms the same throughout the class. The antherid either springs directly from a single cell of the thallus, or results from more or less numerous bipartitions of the antheridiferous cell. The pollinoid is a round or ellipsoidal body, not absolutely naked, but inclosed in a very thin investment, which does not, however, give the reactions of cellulose; it escapes by the gelification of the apex of the antherid.

In *Batrachospermum*, *Nemaleon*, and *Helminthora*, we find the simplest structure and arrangement of the antherids, which spring by budding from the extremities of peripheral filaments of the thallus. Each pollinoid has a nucleus, but no nucleole. In *Callithamnion roseum* the structure is no way essentially different. In *Griffithsia corallina* the antherids are developed at the extremity of particular branches of the thallus, in the form of tufts.

In *Polyides rotundus* the antherids are formed in tetrads on filaments resulting from the prolongation of cortical cells. Their mode of formation recalls that of tetraspores, or even of the pollen-grains of flowering plants. In *Chondria tenuissima* the antherids result from the transformation of hairs which cover the branches, and are produced in a dense row.

In the Melobesiaceæ and Corallinaceæ the form of the antherids and pollinoids is very remarkable. In *Melobesia membranacea* the male conceptacles are clothed with hairs, each of which becomes segmented into a row of antherids. The greater part of the contents of each antherid contracts into a pollinoid, each of which, when it escapes, is furnished with two appendages having the appearance of wings, the remains of the walls which divided the filaments into antherids. In *Corallina officinalis* the antherids are produced in tufts, and are of a very elongated club-shape; and the pollinoid, when it escapes from the antherid, is an oval

* Rev. Bryol., xvi. (1889) p. 37.
† Bot. Ztg., xlvii. (1889) pp. 197–206. Cf. this Journal, 1888, p. 981.
‡ Rev. Gen. de Bot. (Bonnier), i. (1889) pp. 175–86 (1 pl.).

body with a very slender tail-like appendage, the remains of the protoplasm of the narrow stalk-like portion of the club-shaped antherid. The body of the pollinoid is inclosed in a very thin membrane which does not include the tail.

Antherozoids of Fucaceæ.*—M. L. Guignard has investigated the mode of development of the antherozoids of several species of *Fucus*, *Pelvetia*, *Halidrys*, and *Cystosira*, which he finds to agree in all essential particulars; *Fucus serratus* may be taken as a type. Each antherid gives birth to sixty-four antherozoids; the nucleus of the antherid divides first of all, by repeated karyokinetic bipartition, into sixty-four nuclei, distributed uniformly through the protoplasm. In forming the antherozoids, the protoplasm divides and collects round the nuclei; and to each nucleus is attached a chromatophore, at first uncoloured, which becomes subsequently the coloured so-called "pigment-spot." The two cilia of the antherozoid are formed from a delicate peripheral protoplasm-ring. The anterior cilium is fixed, for a portion of its length, to the body of the antherozoid, and serves, when in motion, as an oar; the posterior cilium is inserted at the point of contact of the "pigment-spot" with the protoplasm, is twice as long as the anterior cilium, and serves as a rudder. The mature antherozoid is pyriform, and is, in its origin, a naked cell provided with two cilia and with a "pigment-spot"; and differs there fore in its homology from that of the Characeæ† and other higher Cryptogams, which is derived from the nucleus only of the mother-cell.

Ectocarpus.‡—M. E. Bornet adopts Kjellman's distribution of the species of *Ectocarpus* among three genera,—*Isthmoplea*, in which the unilocular sporanges are partially buried in the frond; *Ectocarpus*, in which they are entirely external; and *Pylaiella*, in which they are intercalary, in a longitudinal row. To the last section belong *E. fulvescens*, *Hooperi*, and *nanus*; and he now gives a detailed description of *Pylaiella fulvescens*. The only known mode of propagation is by zoospores contained in unilocular zoosporanges. These are the largest known among the Phæosporeæ, measuring 13–17 μ in thickness, and 30–35 μ in length, resembling those of *Cutleria multifida*. They have two unequal vibratile cilia; the longer one, pointing forwards, does not exceed the length of the zoospore; they germinate without conjugation. The species is also remarkable from the protoplasmic cell-contents being arranged in stars, resembling the appearance in *Zygnema* except in colour.

Desmarestia aculeata.§—Herr E. Söderström gives a careful description of the anatomical structure of this seaweed. The stem springs from the base of the true thallus or attachment-disc, and branches regularly. The so-called "thorns" are the result of the arrest of growth of certain lateral branches, and afterwards fall off. Some of the branches are clothed with very delicate silky hairs, which result simply from very fine branching of the thallus, and contain abundance of chlorophyll; they also are deciduous, and must be regarded as organs of assimilation. Besides these lateral hairs, the young branches also

* Comptes Rendus, cviii. (1889) pp. 577–9; and Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 137–45 (1 pl.).
† Cf. this Journal, *ante*, p. 417.
‡ Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 1–10 (1 pl.).
§ Bih. Svensk. Vet.-Akad. Handl., xiv., Afd. iii. (1889) No. 3 (16 pp and 1 pl.).

terminate in hairs which are likewise branched. Growth takes place from the activity of a growing point situated at the point of junction of the thallus and the terminal hair. In the mature thallus three primary tissues may be distinguished, viz.:—(1) the assimilating-tissue, which is outermost, and consists of 3 or 4 layers of cells; (2) the intermediate tissue (Füllgewebe), composed of larger cells, with thicker walls; and (3) the central cylinder, consisting of only a single row of cells. Of these the second, which constitutes the principal mass of the thallus, gives birth to two new secondary tissues, the hyphal tissue or conducting hyphæ, and an inner assimilating tissue.

Delamarea, a new genus of Phæosporeæ.*—In the Algæ collected in the island of Miquelon by Dr. Delamare, M. P. Hariot finds a phæosporous seaweed, which he makes the type of a new genus, named after the collector, with the following diagnosis:—Thallus cylindraceus, tubulosus, simplicissimus, subcoriaceus, fibris radicalibus affixus, stratis duobus cellularum contextus; cellulis interioribus majoribus elongatis, versus peripheriam minoribus et brevibus, corticalibus in paranemata inarticulata saccata libera demum evolutis; sporangia unilocularia ovata, magna, inter paranemata per totam superficiem thalli sparsa; sporangia plurilocularia. The species described, *Delamarea paradoxa*, resembles certain Chordariaceæ in its fructification and the structure of its frond, but is distinguished by its non-articulated paraphyses. It differs from *Scytosiphon* in having both multilocular and unilocular sporanges, and in its attachment to the substratum by means of articulated filamentous rhizoids instead of a lobed disc.

Phæodermatium.†—Dr. A. Hansgirg describes a new genus of freshwater Phæophyceæ, *Phæodermatium*, with the following diagnosis:—

Thallus submembranaceus, parvus, punctiformis v. plus minus in substrato expansus, e cellulis pluristratosis (initio unistratosis) pseudo-parenchymatice cohærentibus constitutus. Cellulæ vegetativæ rectangulares v. polygonæ v. subsphæricæ, in cytoplasmate chromatophorum laminiforme parietale, luteo- v. aureo-fuscescens et guttas (granula?) oleose nitentes includentes, membrana crassiuscula achroa subhomogenea præditæ. Membrana in mucum gelatinosum mutata, cellulæ modo Syngeneticearum in statum palmellaceum transeunt. Propagatio fit bipartitione cellulorum in statu palmellaceo (zoosporæ non visæ). The only sp., *P. rivulare*, was found in small streams in Bohemia, attached to a *Chantransia* and coated with lime.

Frond of Chordariaceæ.‡—According to Prof. F. R. Kjellman, the frond of species belonging to this family of seaweeds, although uniform throughout the family in its mature form, yet belongs, according to the history of its development, to four different types, as represented in (1) *Chordaria* and *Leathesia*, (2) *Elachista*, (3) *Scytothamnus* and *Coilodesme*, and (4) an undescribed genus from the Japanese seas.

Distribution of Desmidiaceæ.§—Herr R. Boldt describes in detail the 125 species of desmids found in Greenland, including several new

* Journ. de Bot. (Morot), iii. (1889) p. 156 (1 fig.).

† Notarisia, iv. (1889) p. 658.

‡ Naturv. Studentsälsk. Upsala, Feb. 9, 1888. See Bot. Centralbl., xxxviii. (1889) p. 697.

§ Bih. K. Svensk. Vet.-Akad. Handl., xiii. (1888) Afd. 3, Nos. 5 and 6, 158 pp. and 4 pls. See Bot. Centralbl., xxxviii. (1889) p. 736.

species. From a comparison of these with the desmid flora of other northern countries, he comes to the following conclusions on the distribution of the Desmidiaceæ.

The desmid-flora of Greenland is very nearly related to that of other neighbouring countries, especially Scandinavia. Only one arctic species occurs in Nova-Zembla, Spitzbergen, and northern Greenland which is well distinguished from that of more southern countries. The flora of Norway agrees more closely with the arctic flora than does that of Sweden and Finland. The constitution of the desmid-floras of Spitzbergen and Greenland does not favour the theory of an interchange of species between these countries: but both can be well explained on the supposition of a previous land-connection between these countries and the continent of northern Europe.

Volvox globator.*—According to Drs. M. L. Mallory, G. W. Rafter, and J. E. Line a peculiar odour and taste of fresh fish which has been observed in the water of the Hemlock Lake, near Rochester, N.Y., is due to the presence of vast quantities of *Volvox globator*, though whether in the living state or in process of decay they are unable to say.

Fungi.

Conjugation of Nuclei in the Impregnation of Fungi†—Herr W. Chmielewskij has been able, by the use of clearing-reagents, to make the zygotes of *Basidiobolus ranarum* transparent during the process of impregnation. After two weeks he finds the nuclei still distinct; but after four weeks they had completely coalesced. The coalescence of the nuclei is therefore an extremely slow process; and even after this is completed, the zygote has apparently to go through a period of rest before it can germinate. Unripe zygotes, in which the nuclei are still distinct, will germinate, and there are then two nuclei in the germinating filament.

In *Cystopus candidus* the oogone contains, before impregnation, only a single nucleus, and that of the antherid is the same size as that of the oogone. After the entrance of the male gonoplasm into the oogone, two nuclei could still be distinguished; but these gradually coalesce, and the mature oosperm always contains only one.

Saccharine matters of Fungi.‡—M. E. Bourquelot has investigated the composition of the saccharine substances found in *Boletus aurantiacus*, and in several species of *Lactarius*. He finds the results differ according to the mode of extraction, whether by drying, boiling, or distillation, from which he infers that when fungi are simply dried, the vital processes and consequent chemical changes go on for a considerable period after they are gathered. The results also differ from year to year in the same species, probably in consequence of varying atmospheric conditions. When dried at 100° C., the author found in the various species of *Lactarius* a proportion of mannite, varying between 2·14 and 15·0 per cent.; while the extract with boiling water yielded a certain amount of trehalose, which is probably entirely consumed in the process of drying or ripening.

* '*Volvox globator*, as the cause of the fishy taste and odour of the Hemlock Lake Water in 1888,' 10 pp. and 2 pls., Rochester, N.Y., 1889.

† Arb. Neu-russ. Naturf. Gesell., xiii. (1888) pp. 113–21. See Bot. Centralbl., xxxviii. (1889) p. 789.

‡ Comptes Rendus, cviii. (1889) pp. 568–70.

Mycorhiza-forming Fungi.*—Herr F. Noack finds the stratum of humus beneath the peridium of *Geaster fimbriatus*, which is abundant in pine-woods, to be penetrated by coral-like rootlets of *Abies excelsa* or *Pinus sylvestris*, and these to be invested and permeated by a true mycorhiza springing from the *Geaster*, the filaments of which vary in thickness between 0·3 and 9·0 μ. The following is the history of development of the mycorhiza.

The exceedingly fine hyaline unseptated hyphæ of the mycele unite into thick bundles coloured white by concretions of calcium oxalate, resembling in these respects the structure of young peridia. The hyphæ increase in diameter, and become septated, loop-cells being at the same time also formed, and they gradually become covered with a dense clothing of papillæ. When the rootlet of a conifer penetrates into this mycele, it becomes entirely enveloped by a felt of hyphæ, forming a pseudo-parenchymatous cap over the tip of the root. The root-cap and the root-hairs of the root then nearly or entirely disappear, and it branches into the well-known coral-like form. *Geaster fornicatus* forms a similar mycorhiza, but not *G. striatus.*

The mycele of the following fungi has been observed by Herr Noack to form mycorhiza :—*Agaricus* (*Tricholoma*) *Russula* on beech ; *A.* (*T.*) *terreus* on pine and beech ; *Lactarius piperatus* on beech and on *Quercus pedunculata ; L. vellereus* on beech ; *Cortinarius callisteus* on pine ; *C. cærulescens* on beech ; *C. fulmineus* on oak. Experiments on species of *Lycoperdon*, *Scleroderma*, and *Amanita* all produced negative results.

Structure of Saprolegniaceæ.†—Prof. M. Hartog has carefully examined the structure of the Saprolegniaceæ in the cases of *Saprolegnia Thureti*, *torulosa*, and *corcagiensis* n. sp., *Leptomitus lacteus*, and *Achlya prolifera* and *recurva.* He finds the nucleus to be always vesicular, containing a large central mass of nuclein surrounded by a less refringent layer of hyaloplasm. The nucleus is usually situated in the parietal layer of protoplasm, but may also be found in the strands which traverse the cavity in the larger filaments. The protoplasm contains proteinaceous particles or microsomes. The apex of the filament, whether vegetative or reproductive, contains no nucleus, but a homogeneous hyaloplasm without vacuoles or microsomes. The nuclei divide by constriction. but the phenomena of karyokinesis may also be observed. The formation of zoospores is not preceded by division of the nucleus, but consists essentially of a segregation of the apocytal protoplasm into distinct cells. The so-called vacuoles in the young oogone are rather nuclei in every stage of conjugation. *Achlya prolifera* and *recurva* are truly parthogenetic, the " spermamœbæ " of Pringsheim being in reality parasitic organisms.

Germination of Teleutospores.‡—Dr. P. Dietel enumerates the species of Uredineæ, the teleutospores of which germinate on the living host-plant immediately after maturing, and which can therefore produce several teleutospore-generations in succession in the course of one year. Exclusively of the subgenera *Leptopuccinia*, *Lepturomyces*, and *Leptochrysomyxa*, of *Puccinia*, *Uromyces*, and *Chrysomyxa* respectively, only one other species is known, viz. *Hamaspora Ellisii.* The author sums

* Bot. Ztg., xlvii. (1889) pp. 389–97 (1 pl.).
† Comptes Rendus, cviii. (1889) pp. 687–9.
‡ Bot. Centralbl., xxxviii. (1889) pp. 577–81, 609–12, 657–60.

up his observations with the conclusion that the production of lepto-forms of *Puccinia* and other genera of Uredineæ has no connection with either the systematic position or the anatomical characteristics of the host-plant; it appears rather to depend on climatal conditions.

Tuberaceæ and Elaphomycetes.*—Dr. R. Hesse makes the remarkable statement that the Tuberaceæ and Elaphomycetes should be placed, if among fungi at all, on the extreme limits of the Mycetozoa. In all of them the structure which is known as the receptacle or fructification owes its origin to swarm-cells, which possess the capacity, under certain conditions, of associating themselves into compound bodies, varying greatly in form, size, and colour, but which normally go through certain regular stages of development, and finally, after a variety of changes in form, combine into the characteristic fructifications of the Tuberaceæ and of *Elaphomyces*. That which has hitherto been regarded as the close of the development of these fungi, their process of deliquescence or decay, is in reality the commencement of the true period of reproduction. The small masses of swarm-cells into which these bodies break up resemble quartz-grains in appearance, but are as soft as wax. They are formed especially from the dissolution of the glebe and of warts and scales, and are found in enormous quantities in the humus of the soil, wherever these fungi are decaying.

The author's observations were made on *Tuber maculatum* and *excavatum*, *Balsamia fragiformis*, and a number of other Tuberaceæ and Elaphomycetes; and he believes these observations to hold good with regard to the Hymenogastreæ generally and the typical Lycoperdaceæ, such as *Lycoperdon*, *Bovista*, *Geaster*, *Polysaccum*, and *Scleroderma;* and also that the warts on the receptacle of the Hymenomycetes may have a much more important signification than has been generally ascribed to them.

The author disputes the parasitic nature which has been assigned to the true Tuberaceæ, believing them all to be true saprophytes, while *Elaphomyces* may partake of both characters.

Synthesis of Lichens.†—M. G. Bonnier records the results of a series of experiments on the synthesis of lichens, in which care was taken to avoid previous errors by using only perfectly pure spores of Algæ previously determined, and by preventing the access of other spores. The mode of culture was in Pasteur-flasks or in cells specially prepared, and the substratum employed was pieces of rock or bark free from other organisms and sterilized at a temperature of 115° C. Still the results were sometimes negative, or foreign organisms resulted from the access of air at the moment of sowing. In others lichens were obtained by synthesis corresponding in every respect to those the spores of which were sown.

The Algæ employed were *Pleurococcus vulgaris*, *Protococcus botryoides*, *P. viridis*, *Trentepohlia umbrina* (?), *T. abietina*, *T. aurea*, *Stichococcus bacillaris*, and *Vaucheria sessilis;* and the lichens obtained by sowing in conjunction with them the spores of the corresponding species were as follows:—With *Protococcus*—*Physcia parietina*, *P. stellaris*, and *Parmelia Acetabulum;* with *Pleurococcus*—*Lecanora ferruginea*, *L. subfusca*,

* Bot. Centralbl., xxxviii. (1889) pp. 518–20, 553–7.

† Ann. Sci. Nat. (Bot.), ix. (1889) pp. 1–34 (5 pls. and 6 figs.)

L. sophodes, *L. coilocarpa*, and *L. cæsio-rufa*; with *Trentepohlia*—*Opegrapha vulgata*, *Graphis elegans*, and *Verrucaria muralis*.

The development of *Physcia parietina* is described as follows:—Two spores only were sown, with about thirty *Protococcus*-cells. The germinating filament from the spore elongates at its extremity; the terminal portion swells, often becomes cut off by a septum, and puts out lateral swellings which develope into slender branches; these envelope the algæ, until the latter are completely surrounded by hyphæ of three kinds, viz. swollen filaments, clamp-filaments in immediate contact with the algæ, and elongated filaments which extend towards the periphery apparently in order to search for fresh algæ; the swollen hyphæ are the origin of the pseudo-parenchyme of the lichen.

It is frequently asserted that a constant and essential difference exists between fungi and lichens in the much greater thickness of the cell-walls of the latter; but M. Bonnier has watched the gradual thickening of the walls as the hyphæ of the lichen come in contact with the nourishing algæ; it is not strongly manifested until the pseudo-parenchyme is already partly formed.

Development of Lichens on the Protoneme of Mosses.*—M. G. Bonnier has observed that when the spores of lichens germinate in contiguity with the protoneme of a moss, they may completely invest it and carry on a parasitic existence upon it. He has succeeded in obtaining a parasitism of this kind by inducing the spores of *Parmelia aipolia* and *physodes* to germinate on the protoneme of such mosses as *Hypnum cupressiforme*, *Barbula muralis*, *Funaria hygrometrica*, *Mnium hornum*, *Dicranella varia*, and *Phascum cuspidatum*. The lichen-hyphæ will in such circumstances completely envelope the protoneme and ultimately destroy it, but without producing any fructification. But the protoneme will sometimes produce buds or propagules with very thick cell-walls which offer a resistance to the attacks of the lichen-filaments and preserve the life of the moss. This occurs specially with *Mnium hornum*. The lichen-spores will also sometimes germinate on the leaves of the moss, but will not develope into a perfect lichen unless they meet with algal gonids.

Pilophorus.†—Prof. T. M. Fries unites together the three species of this genus of lichens previously known, viz. *P. robustus*, *acicularis*, and *cereolus*, and describes a new species from Vancouver's Island, *P. clavatus*, distinguished by the very unusual form of the apotheces, which are no less than four or five times higher than broad.

Fungus-parasites of the Alder.‡—Prof. R. Sadebeck states that the grey spots on the leaves of *Alnus incana* are produced by *Exoascus epiphyllus*—identical with *Taphrina borealis*—which also settles on leaves of *A. glutinosa* already attacked by *E. alnitorquus*, producing its asci among those of the latter. The scales of the female catkins of both species of alder are subject to the attacks of an undescribed *Exoascus*, which the author proposes to call *E. amentorum*, resembling *Ascomyces endogenus*, but marked as belonging to *Exoascus* by its abundant mycele.

* Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 165–9 (1 pl.).
† Naturvetensk. Studentsällsk. Upsala, March 27, 1888 (1 fig.). See Bot. Centralbl., xxxviii. (1889) p. 764.
‡ Ber. Gesell. Bot. Hamburg, 1888, p. 90.

Rhizoctonia.*—Herr E. Eidam and Herr E. Rostrup † have studied the mode of parasitism on the beet of the destructive fungus *Rhizoctonia Betæ.* On the roots of the clover, carrot, and beech are frequently found little balls, at first red, afterwards blackish, which become transformed in the spring into pycnids. Rostrup suggests that *Rhizoctonia* is in fact the mycele of fungi belonging to the Ascomycetes.

Parasitic Fungus on the Lombardy Poplar.‡—M. P. Vuillemin describes a destructive disease of the Lombardy poplar as being caused by the attacks of *Didymosphæria populina*, which in the summer assumes its pycnidial form of *Phoma.*

M. E. Prillieux § confirms this observation, and further identifies the parasite with one which attacks the leaves of the aspen in the conidial state, and which is then known as *Fusicladium* or *Napicladium Tremulæ.* This fructifies in the summer as a *Phoma*, in the winter as a *Didymosphæria.*

Entophytes in Myriopods.‖—Prof. E. G. Balbiani describes three new species of entophytes found in the alimentary canal of the myriopod *Cryptops.* One of these, which appears to have been observed by Plateau, he calls *Omphalocystis Plateaui.* It occurs in the œsophagus of *Cryptops punctatus* and *C. hortensis;* moniliform filaments are attached by a basilar cell to the cuticle; and the parasite grows by budding from the said basilar cell by acrogenous or intercalary growth in the filaments, and by lateral budding on the same. Balbiani regards it as a special type of fungi. The second form, also from the œsophagus, he names *Mononema moniliforme;* it has simple moniliform filaments, without a basilar cell, without ramification, and is less frequent than the former species. A third form, *Rhabdomyces Lobjoyi*, was also found in the œsophagus, but only in *Cryptops hortensis.* It consists of isolated cylindrical rods, and is referable to the Blastomycetes. The conids are nucleated, multiply by gemmation, and occur in the walls of the œsophagus, without spreading to other parts of the body. The author also observed in the same hosts what he believes to be a new Gregarine, perhaps the *Dactylophorus* noted by Schneider, and he noticed, furthermore, a Coccidian in the mid-gut.

Heliotropism of Phycomyces.¶—M. J. Massart has establishsd a curious fact in connection with *Phycomyces nitens.* He found that this fungus, when submitted to the opposite actions of illuminations of the same nature, but of unequal intensity, always bent towards the stronger, thus verifying the psycho-physical law of Weber for heliotropism.

Puccinia vexans.**—Herr P. Dietel records the existence in this species of two kinds of teleutospore and two kinds of uredospore. The teleutospores are either unicellular or bicellular. In addition to the ordinary uredospores, there are others which resemble teleutospores, not only in their appearance, but also in the fact that they will apparently germinate only after hibernating; the author proposes for these the term *mesospore.*

* Jahrb. Schles. Vaterl. Cultur, 1888. See Bonnier's Rev. Gén. de Bot., i. (1889) p. 156.

† Overs. K. Dansk. Vidensk. Forhandl., 1888. See Op. cit., p. 156.

‡ Comptes Rendus, cviii. (1889) pp. 632–5.

§ T. c., pp. 1133–5.

‖ Journ. Anat. et Physiol. (Robin), xxv. (1889) pp. 5–45 (2 pls.).

¶ Bull. Acad. Roy. Sci. Belgique, xvi. (1888) pp. 550–2.

** Hedwigia, xxviii. (1889) pp. 177–9.

Saprophytic development of parasitic Fungi.*—Herr B. Meyer finds that the following fungi, which are normally parasitic on living plants, can be induced to develope as saprophytes, though they do not then always develope their organs of propagation:—*Polystigma rubrum*, *Ramularia asperifolia*, *Claviceps purpurea*, and *Protomyces macrosporus*, the last only imperfectly and with difficulty.

Haplobasidion, a new genus of Dematieæ.—In the fifth fascicle of his 'Fungi parasitici Scandinavici exsiccati' Herr J. Eriksson gives the following diagnosis of this new genus:—Hyphæ fertiles e mycelio endophyllo assurgentes, breves, simplices, basidioideæ, apicem versus incrassatæ, ibique (3–) 4 ramis conidiigeris coronatæ, demum replicatæ, deciduisque conidiis cicatricosæ. Conidia globosa, fuliginea, levia. It is most nearly allied to *Stachybotrys*, *Periconia*, and *Cephalotrichum*. *H. Thalictri* grows on *Thalictrum flavum*.

Lactarius piperatus.†—MM. R. Chodat and P. Chuit describe the anatomical structure and chemical properties of *Lactarius piperatus* Scop. It is of a dull whitish yellow colour, the lamellæ being slightly deeper. The fungus is compact and hard, and the fracture irregular but not fibrous. The authors succeeded in obtaining from the fungus a substance with a very biting taste, to which they have given the name of *piperone*. It is soluble in alcohol, ether, and chloroform, and becomes fluid at 100°. *L. piperatus* ought not then to be eaten without being prepared in a manner that will cause it to lose its acridity.

Mycetozoa.

Myxomycetes of Denmark.‡—Herr C. Raunkiær proposes the following classification of the Myxomycetes:—

A. Without capillitium.
- I. HOMODERMEÆ.
  - Liceaceæ (*Tubulina*, *Lindbladia*).
- II. HETERODERMEÆ.
  - Clathroptychaceæ (*Enteridium*, *Clathroptychium*).
  - Cribrariaceæ (*Cribraria*, *Dictydium*).

B. With capillitium.
- III. CŒLONEMEÆ.
  - Arcyriaceæ (*Perichæna*, *Lachnobolus*, *Arcyria*, *Cornuvia*, *Lycogala*).
  - Trichiaceæ (*Hemiarcyria*, *Trichia*).
- IV. STEREONEMEÆ.
  - Physaraceæ (*Badhamia*, *Physarum*, *Tilmadoche*, *Fuligo*, *Leocarpus*, *Craterium*).
  - Didymiaceæ (*Chondrioderma*, *Lepidoderma*, *Didymium*, *Spumaria*).
  - Stemonitaceæ (*Lamproderma*, *Enerthenema*, *Ancyrophorus*, *Comatricha*, *Stemonitis*, *Brefeldia*, *Reticularia*).

The Danish species, 96 in number, are described in detail, and a

* Landwirthsch. Jahrb., 1888, 35 pp. and 4 pls. See Bot. Centralbl., xxxviii. (1889) p. 827.

† Arch. Sci. Phys. et Nat., xxi. (1889) pp. 385–403 (1 pl.).

‡ Bot. Tidskr., xvii. (1888) 88 pp. and 4 pls. See Bot. Centralbl., xxxviii. (1889) p. 676.

large number of them figured. Seven new species are described, and one new genus, viz.:—

Ancyrophorus. Sporocysts stalked; the stalk is prolonged into a columel which reaches to the apex of the sporocyst, and there broadens into a circular disc coalescent with the peridium, the capillitium-threads proceeding from the under side of this disc, and from the upper half of the true columel; these threads branch dichotomously towards the apex; the outermost bend outwards, and are covered with numerous subulate points.

New Myxomycetes.*—Herr M. Raciborski describes the following new species of Myxomycetes from the neighbourhood of Cracow, Poland:—*Lamproderma Staszycii, L. tatricum, Chondrioderma exiguum, Heterodictyon Bieniaszii, Arcyrella cornuvioides, Perichæna Krupii.*

Protophyta.

α. Schizophyceæ.

Cyclophora.†—This genus of diatoms (Tabellarieæ), formed by Count Abbé F. Castracane in 1872, he now proposes to sink altogether in *Diatoma*, regarding his *C. tenuis* simply as a variety of *D. hyalinum*. The character on which he relied for the formation of the genus, the peculiar small circle on each valve, he now finds to have not even a specific value, since it has been observed by himself or others on several species of *Cocconeis*, as well as in *Amphora* and *Navicula*.

Diatoms of African Tripoli.‡—Count Abbé F. Castracane describes the constitution of a tripoli from the elevated valley of Dopi, in North Africa. He finds twenty-four species of diatoms, all referable to existing types, except one new one, *Cymbella Assabensis*. Among them is the very rare *Epithemia clavata*, which has been found also in Lake Nyanza.

β. Schizomycetes.

Number of Bacteria in the Contents of the Gastro-enteric Tube of some Animals.§—Prof. de Giaxa finds that in eight out of ten herbivorous animals there is an increase, which is generally considerable, in the number of bacterian colonies which are developed in a decigramme of the contents of the small intestine, compared with the number found in an equal part of the contents of the stomach. In the large intestine there is always a very considerable increase in the number of micro-organisms as compared with the stomach, and generally an increase as compared with the small intestine.

Among ten omnivorous and carnivorous animals, only one was found to exhibit a slight increase in the small intestine as compared with the stomach; in the other there was always a diminution, and that was generally considerable. In these therefore, in opposition to the herbivora, the small intestine is not a medium which is very favourable for the reproduction of bacteria. In all cases the greatest reproduction of microbes is effected in the large intestine, as may be proved by the quantities found in the rectum.

* Hedwigia, xxviii. (1889) pp. 115–24.
† Atti Accad. Pontif. Nuovi Lincei, xlii. (1889) 9 pp.
‡ T. c., 8 pp.
§ Arch. Ital. Biol., xi. (1889) pp. 229–36.

New Pyogenetic Bacillus.*—MM. Rietsch and du Bourguet describe a bacillus observed by the latter in the affection called the ulcer of Yemen at Beyrout. The bacillus varies a good deal in length, and its width is by no means constant; its mean length is $1 \cdot 5\ \mu$, and it is ordinarily twice as long as wide; sometimes it is so short as to look almost like a coccus. In gelatin it forms colonies under the form of yellowish spots, which soon become mammillated in appearance, and rapidly liquefy their medium. When inoculated hypodermically its action is almost *nil* on pigeons, fowls, and white mice; it produced, in two guinea-pigs, tumours which were absorbed after a few days. The rabbit is more sensitive, and in the pus produced in it the bacillus was found; this gave pure cultures in gelatin. A rabbit killed by it had a large number of the bacilli in the peritoneal fluid, the heart, the liver, and particularly the lung.

New Species of Chromogenous Microbe.†—Mr. G. F. Dowdeswell describes under the name of *Bacterium rosaceum metalloides* a new microbe which forms a remarkable pigment altogether similar to magenta-red. It developes best in solid cultures; and when in full vital activity it varies from 6–8 μ in breadth, and is about twice as long as wide, but may be larger, so that it presents considerable variations in this respect. In this stage it is invariably immobile, and developes rapidly by repeated transverse divisions, but never forms chain, or zoogloeæ of any kind. When it passes into a quiescent stage it forms densely aggregated masses of cells. After a few days it may exhibit the metallic brightness which distinguishes it, and after a month or six weeks it ceases to grow. It developes most vigorously and gives the most richly coloured colonies when inoculated on slices of boiled potato. In certain liquids it gives rise to the formation of gas, and if cultivated in a confined space produces a disagreeable odour. As it cannot resist any elevation in temperature, it cannot have any direct pathogenetic action on warm-blooded animals. It is probably a saprophyte on vegetable materials.

* Comptes Rendus, cviii. (1889) pp. 1273–4.
† Ann. de Micrographie, ii. (1889) pp. 310–22.

MICROSCOPY.

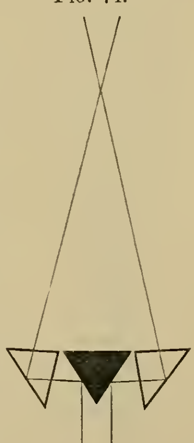
a. Instruments, Accessories, &c.*

(1) Stands.

Binocular Microscopes (Ahrens, Goltzsch, and Holmes).—It is no doubt somewhat rash to attempt to assert that we have reached a final point with regard to any branch of microscopy, but at the same time we are inclined to think that when this notice has been published, all the forms of Binocular Microscope will have been described that it can be at all worth any one's while to invent—at any rate, for any purpose of practical use. The only forms which have hitherto stood the test of use, are those of Nachet, Wenham, and Stephenson.

Ahrens's Polarizing Binocular Microscope.—Hitherto there has been some difficulty, Mr. C. D. Ahrens considers, in using binocular Microscopes with polarizing apparatus, mainly on account of the practical difficulties attending the use of analysing prisms with the double tube for the two eyes. "My invention has for its object the construction of binocular Microscopes in which the difficulty of analysing the light is obviated by employing actual polarizing surfaces to divide the rays as they emerge from the object-glass. This I prefer to accomplish in the following manner:—Over the object-glass is set a prism of black glass having a horizontal side upwards as close to the object-glass as is convenient, and having its two faces symmetrically inclined to the axis of the object-glass at angles of about 57°, which is approximately the angle of complete polarization. The bundle of rays is thus reflected at the proper angle, and divided at the same time into two parts. These parts or rays, passing obliquely right and left, are then reflected up the two tubes to the two eye-pieces, either by two total reflection prisms or by polished metal surfaces. Light polarized by a suitable polarizer before traversing the object, will be analysed by the said prism or prisms placed above the object-glass." The prisms are shown in fig. 74.

FIG. 74.



Goltzsch's second Binocular Microscope.† — We have already described ‡ Herr H. Goltzsch's first binocular Microscope, one of the features of which was the use of small telescopes for eye-pieces. He subsequently announced an improvement, by which the inconvenient vertical stage is dispensed with.

Close above the objective a rectangular prism is placed, the anterior acute angle of which is in the axis while the hypothenuse surface is inclined at an angle of $3\frac{1}{2}°$, so that half the pencil from the objective is diverted, to the extent of 7° from the axis, by total reflection. Behind the

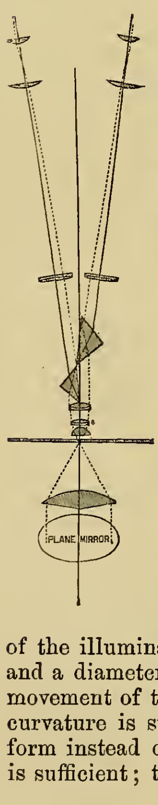
* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Carl's Rep. f. Exper.-Physik, xviii. (1882) pp. 27–32 (1 fig.).

‡ See this Journal, 1882, p. 95.

first prism is a second one, rather larger, but of similar form, the anterior acute angle of which projects slightly over the axis. This prism also diverts the other half of the rays to 7° from the axis. The pencils diverge upwards at an angle of 14° and at about 8 inches above the apex of the angle they are separated from each other by approximately the medium distance of the eyes apart. The telescopes which replace the eye-pieces have achromatic object-glasses and the usual double eye-lenses, and by means of rackwork can be moved so far on their axes as may be requisite for a decrease in the width of the eyes. The prisms are inclosed in a box, which, like the tube of an ordinary Microscope, can be raised or lowered by rackwork or a micrometer-screw. The size of the lower prism must be regulated according to the largest objective-lenses employed; the other may be somewhat (or even considerably) larger; this is advantageous in that a longer path of the rays in the glass moves the apex of the diverging axes lower down, and thus aids in limiting the height of the whole instrument. An aperture on the upper side of the box, central with the principal axis, allows of the insertion of a tube with a small opening, or an ordinary eye-piece, by means of which an exact adjustment of the prisms is made, it being necessary that a point of the object seen through the eye-piece in the centre of the field of view after the prisms are removed should also be in the centre of the telescopic field when the prisms are used.

Fig. 75.



The question of illumination is an important point. The plane-mirror is never sufficient alone for any kind of binocular Microscope. The concave can be employed if it is movable freely in the axis without lateral movement. Still better is a plane-mirror in conjunction with a movable convex lens, which can be removed from the stage to double its focal distance. This mode of illumination is, however, very disadvantageous for the production of sharp images; the light is often far too dazzling, and small diaphragms are consequently necessary. With the Stereo-Microscope these should never have the apertures round, but in the form of slits, placed at right angles to the edges of the prisms; seven or eight of these (from the narrowest to about 2 mm.) may be arranged radially upon an ordinary wheel of diaphragms. The plano-convex illuminating lens shown in fig. 75, used with a plane mirror, is, however, a much more suitable arrangement. Upon the plane surface of this lens two prisms are so placed that their thicker sides unite in the central line, this being parallel with the edges of the prisms. Such a lens forms two separate images of the illuminator; the two sets of rays intersect at a point a little above the lens, where the object is to be placed. Both fields of view are in this way equally illuminated with diffused light without showing an image of the illuminator itself. The lens has a radius of curvature of 32 mm. and a diameter of 40 mm., and the angle of the prisms is $8\frac{1}{2}$°; for the movement of the lens in the axis a space equal to twice the radius of curvature is sufficient. It can also be made in a quadrangular oblong form instead of round; in this case a central piece half as wide as long is sufficient; the light has then freer access to the mirror.

The author adds some remarks as to the special objectives necessary for a Microscope with telescopic eye-pieces. It must not be expected, he says, that proper images can be obtained with objectives which are suitable for ordinary Microscopes; for not only does the bisecting of the rays influence the quality of the images, but the course of the rays is quite different. We must have, therefore, objectives specially corrected for parallel pencils. The lenses of an ordinary objective are placed closer together, as though to suit very thick cover-glass. The object is of course at the focus of the objective instead of being outside it, as in the ordinary compound Microscope, or within it, as in the simple. The results already obtained justify, it is said, the hope that the moderate magnifying powers hitherto reached (scarcely above 200) can be considerably increased. With a power of 120 the striæ on the scales of *Hipparchia Janira* were well seen, with an eye-piece power equal only to the weakest now used; with stronger eye-pieces the power could easily be doubled.

Fig. 76.

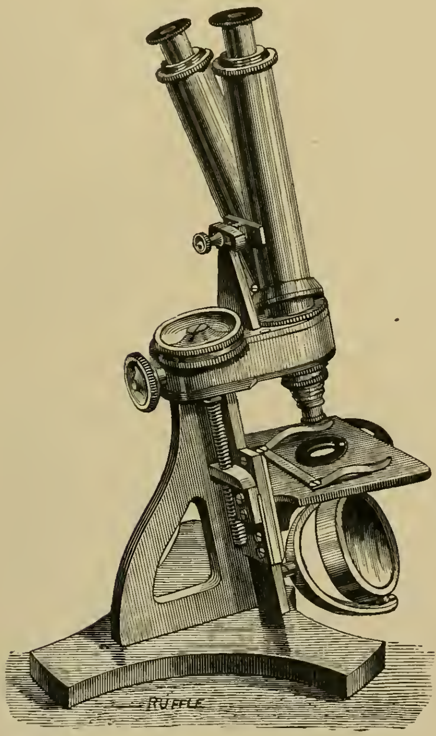


Fig. 77.

Holmes's Isophotal Binocular Microscope.—This is shown in fig. 76. The optical principle of the instrument was described at p. 870 of Vol. III. (1880). A peculiarity of the mechanical arrangement is that the tubes are made to rock from side to side on a socket. The object of this is to enable one of the tubes to be brought in a line with the optic axis, when the Microscope is to be used as a monocular. The tubes are clamped in any given position (whether for monocular or binocular use) by a screw working in the short vertical piece shown behind them. The screw at the top of the standard acts on the stage and forms the only adjustment for focus. The isophotal prism slides inside the crossbar and is pushed forward over the objective, or withdrawn again when not required to be used, by the screw at the back of the bar.

There is a second body-tube also of peculiar construction (fig. 77) which has three tubes. The two outer ones are for use with the binocular prisms, while the central one serves for monocular observation.

Blix's Microscopes for measuring the radii of the curved surfaces of the eye.* — Dr. M. Blix uses two compound Microscopes for measuring the radii of the curved surfaces of the eye. Hitherto the surfaces have been considered as mirrors, in which, the smaller the image of any object, the smaller are the radii. The principle which Dr. Blix makes use of is the following:—

The image of a point in the axis of a spherical mirror, lies in the axis at a distance from the reflecting surface, which is determined by the distance of the luminous point from the mirror, and by the radius of the latter. If a compound Microscope, which transmits a ray of light from a point in the centre of the plane of the eye-piece to the objective, be placed in the direction of the normal to the reflecting surface and then adjusted so that the point of intersection of the normal with the reflecting surface—the principal point—is focused, then the image of the illuminating point will be at the same place as the point itself. If the centre of curvature of the reflecting surface is then focused the image will again coincide, but this will not take place in any intermediate position. If the displacement of the Microscope along its axis in the two cases is measured it will enable the radius of curvature of the mirror to be determined by calculation.

This result, however, is not so easily obtained in practice, as the field of view is too strongly illuminated by the light reflected from the surfaces of the objective-lenses. Two Microscopes are therefore employed by Dr. Blix, one to transmit the light and the other to observe its image. The axes of these two Microscopes intersect each other, so that the angle between them is bisected by the normal to the reflecting surface; they can be moved towards the reflector in such a manner that the point of intersection of their axes coincides with that of the normal and the reflector. The object (e. g. a diaphragm with a punctured cross brightly illuminated) in the field of the first tube, is by the shifting of the tube so adjusted that the image projected by the Microscope falls on the reflecting surface. By moving the second tube along its axis, the image of the cross is brought into its field also. If the Microscopes are now moved *together* in the direction of their axes, the image of the cross will disappear from the field of the second Microscope but will reappear as soon as the tubes are focused on the plane of the centre of the reflecting surface. By measuring the extent of movement of the tubes, the radius of curvature can be obtained.

* Zeitschr. f. Instrumentenk., i. (1881) pp. 381-90 (6 figs.). Cf. also Centr.-Ztg. f. Optik u. Mechanik, iii. (1882) pp. 33-4.

Figs. 78 and 79 will serve to illustrate the two positions of the Microscopes T and T_1, when adjusted first to the surface of the reflector A B (H being the "principal point") and afterwards to its centre C, o and o_1 being the objectives; d the eye-piece of the Microscope, and d_1 the diaphragm in the other, and a a_1 the points in the plane of the centre of curvature to which the Microscopes are directed in the second position.

The complete instrument with the two Microscopes is shown in fig. 80. It is fixed on a cast-iron table T which also supports F, Q, R for holding the head of the patient in the required position. Each Microscope has a tube for the objective o, and an inner eye-piece-tube

Fig. 78.

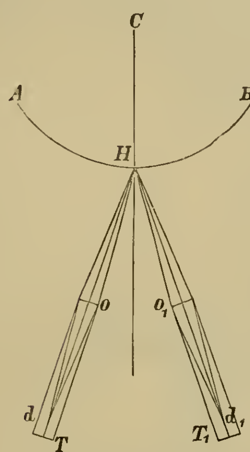
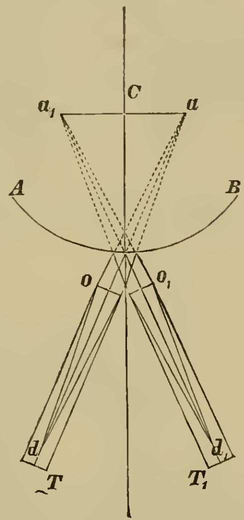


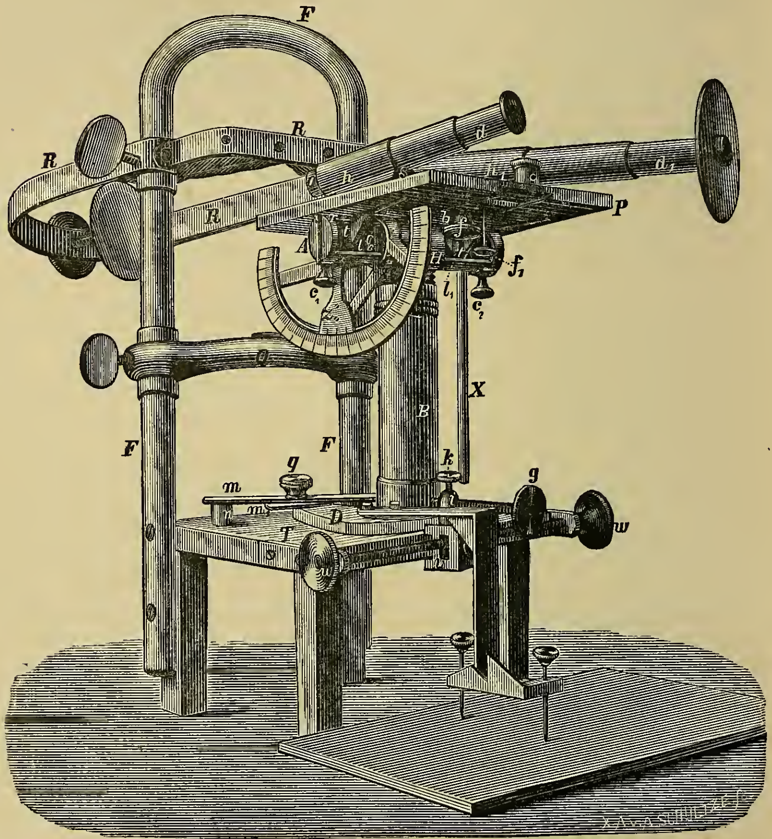
Fig. 79.



d and d'. In the right tube the eye-piece is replaced by a small round plane mirror from the centre of which the silvering is removed in the form of a cross. The left tube has a Huyghenian eye-piece, with cross-threads. Both objectives are of equal power with a focal length of 40 mm. The Microscopes are placed in two short tubes h h_1 attached to supports s s_1 which rest on the plate P. In the latter are guides, which regulate the movements of the tubes, so that they can only move in the direction of their axes. For displacing the tubes an eccentric movement is employed consisting of a cylindrical steel axis A, with a radius of 12 mm., protected by a brass sheath H attached to the stand, so that it lies horizontal and immediately under the plate P, at right angles with the vertical plane bisecting the angle between the tubes. At the sides, semi-cylindrical portions l l_1 are removed, in order to give room for the lowering of the triangular pieces t t_1 connected with the tubes. From the apices of these pieces is cut a slit at right angles to their base in which slides (pressed with a spring) a cylindrical steel rod r, 4 mm. thick, which lies within the periphery of A, parallel to it and at a distance of 10 mm. This distance can be regulated by four screws c_1 c_2 c_3 c_4. If the axis is revolved on its centre by the handle X, the rod will describe a curve, and sliding in the two slits, will move the triangular pieces and with them the tubes forward in a horizontal plane.

An index *z* (with a vernier) on the axis A serves to measure the angle made by the revolution of the axis, on a scale graduated from the

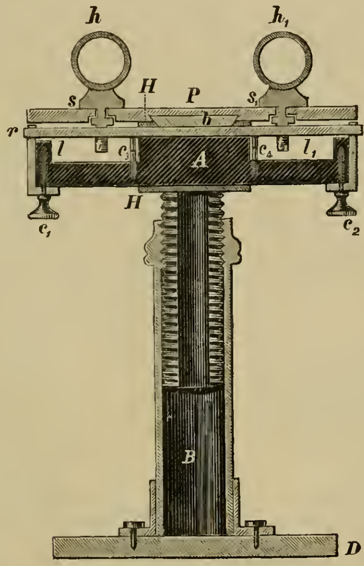
Fig. 80.



central point of the arc to 90° in either direction, whence the length of the radius can be calculated by appropriate formulæ given by the author.

If however what is required is to determine the distance between the principal points of *two* reflecting surfaces on the same axis—for instance, to measure the thickness of the cornea—an arrangement is necessary by which the point of convergence can be moved from the principal point in the one surface to that in the other, the common axis of the two surfaces bisecting the angle between the tubes. The latter must therefore be capable of being moved *parallel with this axis without changing their relative position.* For this the same eccentric mechanism is used as described above. The plate P is not fixed immovably to H, but a thin plate *b* soldered to the latter, is inserted between them and on this the plate P moves (see fig. 81); screws *f* and f_1 fix P to *b*, and by means of two other screws the tubes and P can be firmly united. H is attached to the column B which can be lengthened, thus raising the plane of the tubes. The plate D is connected with the table T in a special manner (movable by the hand or by screws) which needs no particular description here—the mechanism is shown at *g*, *i*, *k*, *m*, m_1, *n*, *q*, *v*, and *w*.

FIG. 81.



In a later form Dr. Blix has simplified the instrument, principally by the omission of the cylindrical axis A and the parts in connection with it.

Andrew Ross's Screw and Pinion Coarse- and Fine-Adjustment.—Amongst an accumulation of pieces of experimental mechanism devised in connection with the Microscope at various times during the past sixty years, we recently found one of the earliest fine-adjustments designed by the late Andrew Ross, which is shown in figs. 82 and 83, and which comprises a coarse- and fine-adjustment in one piece of mechanism.

In place of an ordinary rack for the coarse-adjustment there is a long screw the thread of which serves as a rack. The screw is sunk in a groove cut vertically in the back of the stem F supporting the cross-arm and body-tube, leaving about one-third of its transverse section to be acted upon by the pinion D (and milled head E) for the coarse-adjustment. The upper end of the screw passes through the cross-arm B, and a milled head A is applied on the top by which it can be turned, the screw-thread then engaging the teeth of the pinion after the manner of a tangent-screw, so that the screw, together with the stem and body-tube, travels slowly up or down, forming a fine-adjustment.

We found the mechanism as left by Andrew Ross, and it has since been applied to a stand by Mr. Anderson, who informs us that he assisted in the original construction about fifty years ago.

Fig. 82.

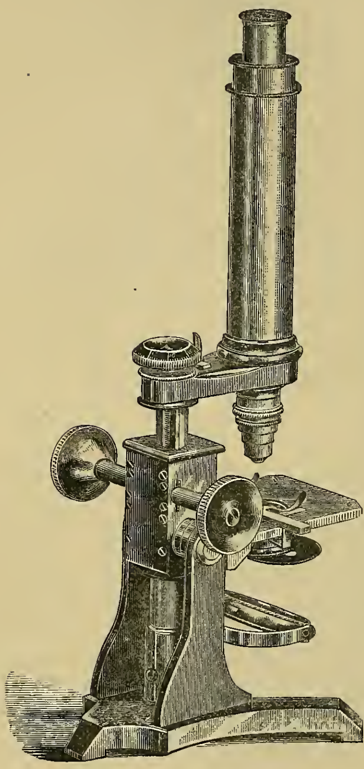
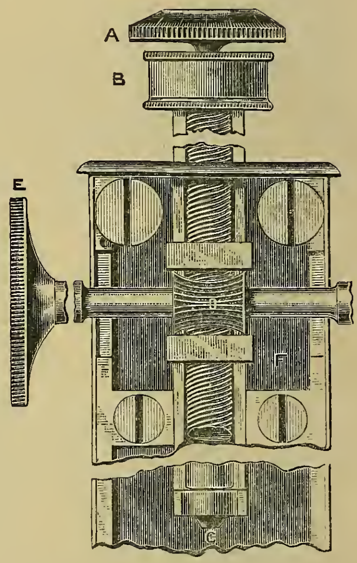


Fig. 83.



M'Intosh's Microscope-Attachment.*—Dr. L. D. M'Intosh devised this apparatus for use with solar or artificial light for projecting or photographing microscopic objects with oblique illumination, or projecting opaque objects, and before describing it he explains the construction of his solar Microscope and stereopticon combination (fig. 84). The optical parts can be used with either solar or artificial light, with only slight changes. To use sunlight, there is a plane mirror M, 12 by 14 in., which turns on a vertical horizontal axis by means of spur-wheel gears connected with rods R, R. The gears are supported by a bracket, which is securely clamped to a perpendicular board F. On the front of this board is an opening to receive the condensing lens, which is mounted in a brass tube C, with draw-tube. The draw-tube E has a screw-thread to receive either the microscopic attachment K, for projecting microscopic objects, or a stereopticon lens for projecting photographic transparencies. By means of the thumb-wheels V, W, the

* Proc. Amer. Soc. Micr., x. (1888) pp. 155–8 (4 figs.).

mirror can be adjusted at any angle desired for illuminating a transparency or microscopic object.

To use the solar Microscope or stereopticon, place it in a window exposed to direct sunlight, and adjust the mirror so that the light enters

FIG. 84.

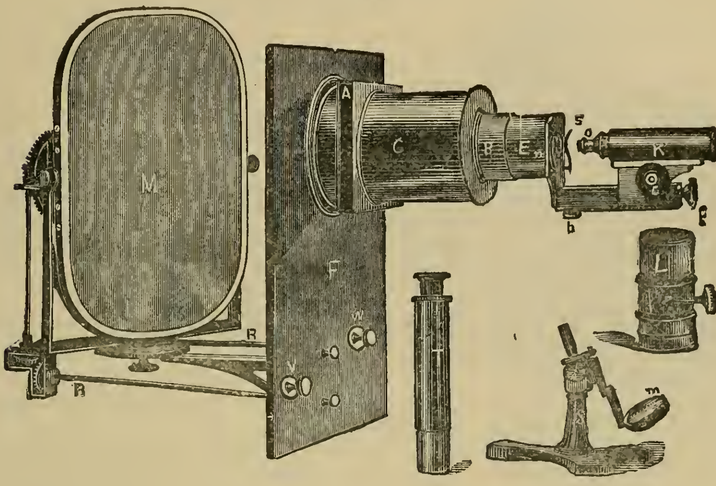
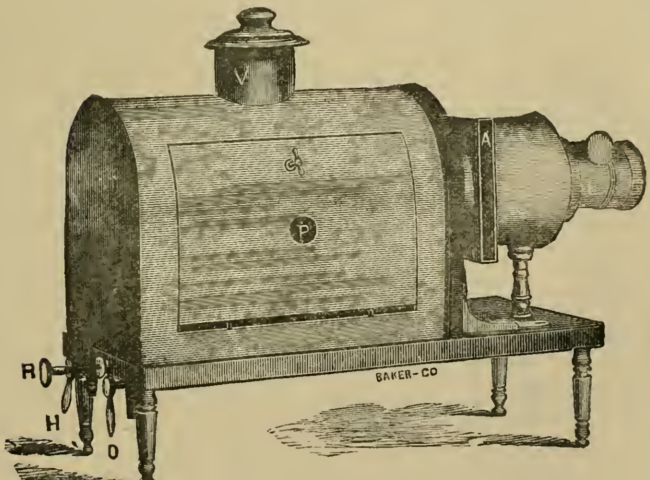
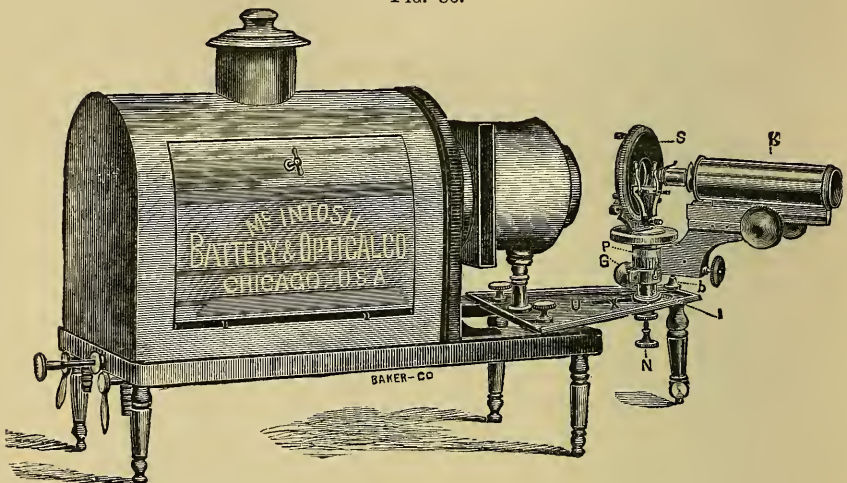


FIG. 85.



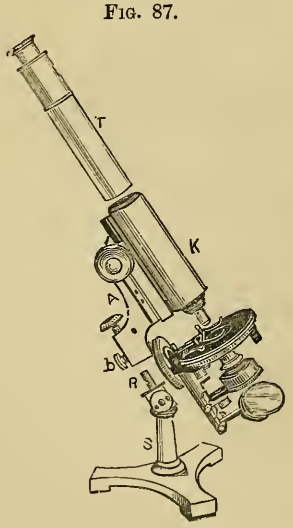
the condensing lens parallel with its axis; adjust Microscope or stereopticon lens; place the object on the stage, or, if a transparency, in front of the condenser, and a well-defined image is seen on the screen. To use the optical parts of the instrument just described with artificial light, viz. oxy-hydrogen or electric, remove the brass tube C, containing the condensing lens and draw-tube, from the mirror attachment and connect to the combination stereopticon (fig. 85), using either the stereopticon lens or Microscope as desired. The light is centered and adjusted

Fig. 86.



by means of thumb-screws on the oxy-hydrogen jet. The adjustment is the same as with solar light. The only change (two condensing lenses are used with artificial light), one of these lenses is removed and only one used, and a small secondary condenser placed under the stage of the Microscope. With this combination just described we can only project, with transmitted light, transparent objects.

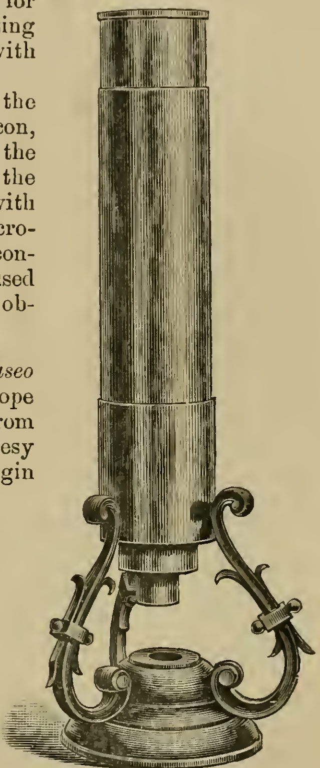
Fig. 87.



The attachment, fig. 86, is for photographing and projecting objects with oblique illumination, or projecting opaque microscopic objects. It is constructed as follows:—To the base of the combination stereopticon is clamped a triangular piece of brass U, by means of thumb-screws, with a slot X near its apex, to hold a movable hollow pillar I. This pillar is slotted on one side, and has a screw and clamp G to hold a perpendicular pinion P, which in turn receives the stage and working part of the stand (fig. 87). This is securely clamped by means of the screw G, fig. 86. Extending through from the lower end of the pillar I is a screw *h* for raising or lowering the stage of the Microscope and body-tube. The body-tube K of the Microscope is in a horizontal position, and the stage S vertical. These are directly in front of the condensing lens. By means of the pinion P in the pillar I, the Microscope can be rotated horizontally to the right or left. The centre of an object on the stage corresponds with the centre of motion. By means of this rotation any angle, either of solar or artificial light, can be obtained for photographing and projecting, also projecting opaque microscopic objects, or projecting with transmitted light.

To use the attachment with solar light, the plate U can be removed from the stereopticon, and attached by means of a bracket to the front of the mirror-board (fig. 84, F) of the solar instrument, adjusted the same as with artificial light. For photographing microscopic objects a camera-box must be connected with the tube K, the same as is used with transmitted light to illuminate the object.

Fig. 88.



Old Italian Microscope.—In the *Museo Copernicano*, Rome, we noted the Microscope shown in fig. 88, which is reproduced from a photograph that we obtained by the courtesy of the Curator, Dr. A. Wolynski. The origin is unknown, but it may, we think, be inferred with some probability to be a very early form of Microscope from the fact that it was evidently devised for viewing opaque objects only. Our conjecture is that, from the peculiar design of the nose-piece, it may have been a very early modification of a "Divini" Microscope. The body-tube slides through the tube-socket, which is supported by ornamented tripod scrolls on a raised base; the whole is of brass. The eye-piece lenses are held in their cells by a thin plate of brass notched out, the teeth being merely folded on the edges of the lenses.

AMATEUR.—**Notes on the Microscope-stand and some of its accessories.** [The foot or base—The supporting pillars—The arm—The body.]
The Microscope, IX. (1889) pp. 264–75.

BEHRENS, W., A. KOSSELL, and P. SCHIEFFERDECKER.—**Die Gewebe des menschlichen Körpers und ihre mikroskopische Untersuchung. Band I. Das Mikroskop und die Methoden der mikroskopischen Untersuchung.** (The tissues of the human body and their microscopical examination. Vol. I. The Microscope and the methods of microscopical research.)
viii. and 315 pp., 193 figs. 8vo, Braunschweig, 1889.

MATTHEWS, C. G., and F. E. LOTT.—**The Microscope in the Brewery and Malt-house.** xxi. and 198 pp., 30 figs., and 22 pls. 8vo, London and Derby, 1889.

Microscope, The New Acme No. 5 with rack and pinion.
Queen's Micr. Bulletin, VI. (1889) p. 25 (1 pl.).

Watson & Sons' Edinburgh Student's Microscope.
Engl. Mech., XLIX. (1889) p. 471 (3 figs.).

WOOLMAN, G. S.—**Selecting a Microscope.**
Amer. Mon. Micr. Journ., X. (1889) p. 182.

(3) Illuminating and other Apparatus.

Taylor's Oleomargariscope.*—During the prosecution for violation of the Butter Laws of the District of Columbia, it was found necessary in jury trials to have a simpler form of microscopic and polariscopic combination than the cumbrous stand, with polariscope, in general use, since each of the parties interested —judge, jurymen, and attorneys— desired to see for themselves the crystalline forms seen in the fatty compounds known as oleomargarine. To this end Dr. J. Taylor contrived the oleomargariscope, illustrated by the accompanying figs. 89 and 90.

Fig. 89.

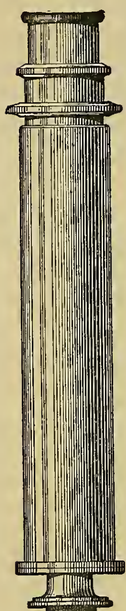


Fig. 90.

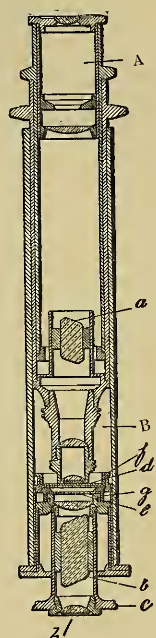


Fig. 89 represents its general appearance when not in use. Fig. 90 represents a sectional drawing showing its internal structure.

A, an ordinary eye-piece.

B, a 1/2 in. objective of the usual construction.

a, Nicol's prism or analyser.

b, polarizer firmly secured in tube *c*, which tube may be rotated as desired, thereby changing the prismatic colours.

d, two discs of thin plate glass, between which a small portion of butter or oleomargarine is placed, the discs held in position by ring *f*.

e, a disc of selenite held in position by ring *g*.

h, a lens for the double purpose of illuminating the polarizer and protecting it from dust.

A lens is also placed over and above the polarizer *b*, which concentrates the light on the object between the discs *d*.

It will be seen from the drawing that the objective is readily focused by means of the draw-tube.

When the object is held up to a strong light, if the butter is pure and free from adulteration, an even green or red colour only will be observed, depending upon the character of the selenite used. If "oleo" or lard is used instead of pure butter, a fine display of prismatic colours will be observed.

Recent Improvements in Electric Lighting applied to Micrography and Photomicrography.†—Dr. H. van Heurck describes the Radiguet battery and electric lamp of Prof. Engelmann, a combination very serviceable for the microscopist, since it affords a bright light whose intensity is under perfect control, and the cost of maintenance is very trifling.

Each element of the Radiguet battery comprises a stoneware jar, a carbon cylinder, a porous pot, and an amalgamating support with its

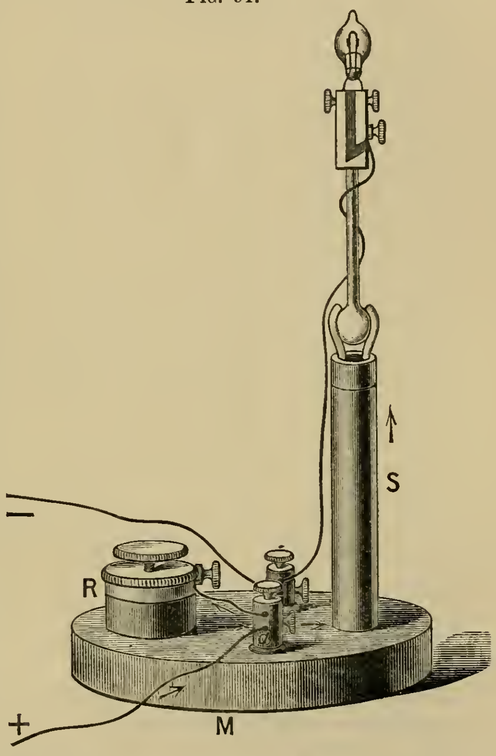
* Proc. Amer. Soc. Micr., x. (1888) pp. 159–60 (2 figs.).
† Bull. Soc. Belg. Micr., xv. (1889) pp. 24–31 (4 figs.).

reservoir. The construction of the latter, in which alone the battery differs from that of Poggendorf, depends on the fact observed by Radiguet that when mercury containing traces of zinc is in contact with copper, the current tends to transport the mercury over the whole surface of the copper. It consists of a copper tube, coated with zinc, carrying a sort of basket which holds the zinc in the form of small balls. Beneath the basket is a porcelain dish which contains the amalgam, and is connected by a copper rod to the two metal pieces forming the base of the basket.

To start the battery an acid solution of sodium bichromate is poured into the outer jar and pure water into the porous pot. The liquid in the latter requires changing every week, and that in the outer jar every month. This is easily effected, without dismounting the battery, by the use of the Radiguet siphon. The larger arm of the siphon is connected by tubing with a caoutchouc ball, and incloses the narrower tube which forms the other branch. The lower extremity of the larger arm is narrowed, so that when the ball is gently pressed, the increase of pressure in the tube forces the liquid into the narrow branch and the siphon functions. By a strong quick pressure, on the contrary, the liquid is driven completely out of the tube, and the action is stopped at will.

The EMF of the battery is about two volts, and the best arrangement for maintaining a steady light for a considerable time is to unite for quantity two series of three elements.

Fig. 91.



The apparatus designed by Prof. Engelmann (fig. 91) consists of a copper base M carrying the rheostat R and lamp. The path of the current is seen from the figure, connection between rheostat and lamp being made by a rod of copper. The lamp can be adjusted in height by means of the two copper tubes S sliding one within the other, and can be brought into any position by means of the ball-joint. The rheostat consist of a cylinder of copper insulated from the base by ebonite or serpentine, and containing a pile of thin discs formed by a mixture of graphite and gelatin. By means of the screw the discs can be more or less compressed together, and thus the resistance regulated with great nicety.

An improved form of the apparatus, constructed by M. Kagenaar, consists of a copper plate, 20 cm. by 10 cm., supporting at one end the lamp as described above, and on the rest of its length a horizontal complementary rheostat. The latter consists of a long tube of serpentine inclosing 120 discs of graphite, and gives a range of resistance from 1/4 ohm to 1000 ohms.

LEACH, W.—**A substage Condenser for the Microscope.**
Trans. Manchester Micr. Soc., 1888, pp. 76–8 (6 figs.).

MILES, J. L. W.—**Sub-stage Illumination by simple devices.**
Ibid., 1888, pp. 78–80 (1 pl.).

(4) Photomicrography.

"Artistic Photomicrography attained." *—Dr. W. X. Sudduth recently gave a lecture on histology before an American Dental Society, illustrated with the aid of the stereopticon, which is reported as follows:—

"He exhibited the results of his experiments in colouring slides in facsimile of the stained specimens which had been photographed. The Microscope is undoubtedly valuable in investigating tissues; nevertheless the reported discoveries of microscopists are not always reliable. Great obstacles arise in the use of the instrument, even after the specimen has been mounted, not the least being the fact that focusing is necessary, and that no two men see exactly alike. Therefore, when A focuses on a specimen to show a certain peculiarity, which he claims to be able to discern, he finds it difficult to demonstrate his discovered fact to B, because B cannot tell when he focuses whether he is viewing the same plane seen by A. Of course, when examiners are experienced microscopists the difficulties are lessened, because the trained eye is familiar with the appearances of different tissues, and this materially assists in obtaining the true focus. For example, suppose A claims to show lacunæ and canaliculi in a specimen of cementum. B is acquainted with the microscopic appearance of dentine, and in focusing aims to get the tubuli of the dentine which is adjacent to the cementum distinctly outlined, and having done so, knows that the cementum also is in focus, and should be able to see the lacunæ if present. Again, it is only the trained eye which is able to distinguish breaks, tears, or foreign bodies (as shreds of lint, &c.), and the surfaces of the tissues from the sides or thickness; profile views look flat, not only at the edges of the specimen, but at all points over the surfaces; shadows become lines, and resemble special features of tissues. To lessen these difficulties various methods of staining are resorted to, it being known that different kinds of tissues are differently acted on by the same agent, thus producing various tints, and materially aiding in the differentiation of tissues, which may thus be recognized by their known colours if the stain used be known. It also shows plainly breaks, tears, and foreign bodies.

"Having prepared and mounted a specimen, in order to show what he sees with his instrument, the investigator may reproduce as accurately as possible with his pencil the picture in the field of his vision. These drawings from specimens, however, only carry weight in proportion to the honesty and ability of the artist. Therefore, as Dr. Sudduth truly says, drawings made by photolithographic processes are the more valuable, being above suspicion of inexactness or perversion through

* Odontographic Journal, x. (1889) pp. 44–8.

bias. The tissues themselves have been used as lantern slides, but high lantern power and intensity of light are requisite, and he knows of but two lanterns capable of such demonstration, one being the Stricker lantern. . . . .

"Having stained a specimen, and thus made distinct the differentiation of tissues, the advantage is again lost in the photomicrograph, because, of course, the colouring is not reproduced, the picture being only one of lights and shades. This has been remedied to some extent by having the lantern-slides painted by hand, and by re-touching, thus making more prominent the outlines. Some have attained high excellence in this art, but it is open again to the objection of bias. An artist might colour his slide to prove his theories. Dr. Sudduth has experimented arduously, hoping to find a method by which he could colour slides by such a process as would dispose of this objection, and enable him to project on the screen facsimiles of the stained specimens, making the lantern picture appear as does the specimen itself under the Microscope. His exhibit proved that he has succeeded marvellously well. He has done this not by hand-work, but by a process of toning in the dark room. He has been specially successful in reproducing the purple and pink of hæmatoxylin and eosin, Bismarck brown and gentian-violet.

"He showed on the screen not only coloured slides, but also some untinted. Conspicuous among these were beautiful specimens of the forming blood-corpuscles in the mesoblast of the pig embryo, white and red corpuscles of human blood, oval corpuscles from the thrush, similar but larger ones from salmon, oyster-shaped corpuscles from the frog, and a most beautiful slide showing the enormous corpuscles from the *Amphioma* (a species of lizard). As showing comparative analogies and differences between blood of various species these slides were specially gratifying. . . .

"Then began the specimens in colour. A slide showing stellate reticulum exemplified how well he reproduces the hæmatoxylin and eosin stains. Next followed the apex of a tooth, showing Tomes's fibres retouched. Several slides were shown of the rete Malpighii coloured by hand, and also by the Doctor's method, which latter seemed vastly more satisfactory and truthful. One of these in Bismarck brown demonstrated how a single stain may be used, the lights and shadows being differently affected; for which reason he thinks this particular stain will prove most valuable. A specimen showing the pigment layer of the retina in gentian-violet was much admired. A segment from the mesentery was very clear and distinct. Stained with silver the result was dark lines against a yellow background. Nuclei show as brown points. A few slides in gentian-violet were shown, but this we were told is the most difficult of the colours to manage. A very beautiful slide was from a macroscopic specimen, stained methyl-green, a section of the finger showing the soft tissues and the bone, also the forming nail of a three months' human fœtus. This was shown because it is the only colour with which he has succeeded in differentiating the nail, which usually appears so light that it is very indistinct. In this picture it was quite plainly seen. Some slides followed showing developing bone, cartilage, &c., and then one of special interest, showing the mesoblastic tissue forming periosteum and pericementum, which is the first differentiation into a membrane; these two tissues, which so many claim to be different, are shown to be similar, being similarly developed.

"In the discussion which followed the termination of Dr. Sudduth's talk, Dr. Allen admitted that much credit was due to Dr. Sudduth for his success in colouring slides, but whilst the staining of specimens was of value as aiding the differentiation of tissues, he, Dr. Allen, could not see what was gained by colouring slides. Whilst this is undoubtedly true, the plain photomicrograph being perfectly intelligible to the trained eye, it was the general opinion among the members present that the coloured pictures were more satisfactory to those not so well acquainted with the tissues."

Photomicrography and the Chromo-copper Light-filter.*—Dr. E. Zeltnow claims that his light-filter fulfils the two conditions required of it, namely, it only allows rays clearly visible to the eye and those of a definite wave-length to pass through, and when used in a concentrated form wave-lengths of from 570 to 550 only traverse the filter, so that the light may be fairly called monochromatic. With ordinary objectives perfectly sharp negatives are obtained. The filter is made by dissolving 160 grm. of pure dry nitrate of copper and 14 grm. of pure chromic acid in water up to 250 ccm. A solution more easily made and sufficient for almost all cases in a layer of 1 to 2 cm. thick is composed of 175 grm. sulphate of copper, 17 grm. bichromate of potash, and 2 ccm. sulphuric acid in water up to 1/2 litre. With a mineral-oil lamp the latter fluid may be diluted with an equal or double volume of water.

Since ordinary dry plates are but little sensitive to light which has passed through this filter, erythrosin plates must be used. These are produced by bathing the former in a weak solution of erythrosin (1 grm. erythrosin dissolved in 500 ccm. spirit and 5 ccm. of this solution with 200 ccm. of water are used for each bath). These plates will only keep for three or four weeks at the most, but erythrosin plates can be obtained from the makers which will last from three to six months. Owing to the erythrosin the plates are very sensitive to yellow-green rays with a wave-length of 560.

A fluid very similar in outward appearance to the chromo-copper filter can be made by the supersaturation of copper salts with ammonia and dilution with chromate of potash. This, however, only allows such green rays (510–455) to which the erythrosin plates are little sensitive to pass through. Preparations stained red, blue, green, blue and violet, are easily photographed by aid of the chromo-copper filter, since in consequence of the extinction of these colours the preparations appear black on a green ground.

Simmons, W. J.—**Magnification in Photomicrography.**
Amer. Mon. Micr. Journ., X. (1889) p. 180.

(5) Microscopical Optics and Manipulation.

Simple Apparatus for measuring the Magnification of Optical Instruments.†—The usual method of measuring magnifying power consists in comparing the image of an object of known dimensions, seen by one eye through the instrument, with another object seen at the same time by the other eye. By a simple optical arrangement, however, both can be seen simultaneously by the same eye, which is the principle of the apparatus constructed by Dr. A. Oberbeck. Two rectangular mirrors

* Eder's Jahrb. f. Photogr. u. Reproductionstechnik, 1889.
† Central.-Ztg. f. Opt. u. Mech., x. (1889) pp. 176–7 (3 figs.).

(fig. 92), 25 mm. long and 15 mm. broad, are set in a rectangular frame at a distance of 6 cm. apart. They are movable about the axes A B and C D and can be fixed in any required position by means of the screws A and C. The frame is fastened to a stand adjustable in height, and is movable about the axis E F. The mirror A B has a portion in the middle plain. For determining the magnifying power of a Microscope the frame is set horizontally, and both mirrors are fixed at 45° to the horizontal with A B directly above the eye-piece, and C D above the object intended for comparison which lies by the side of the Microscope and is seen by double reflection at the same time as the image of the

Fig. 92.

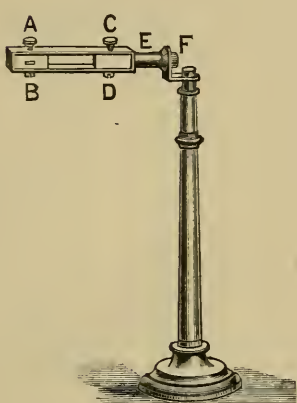


Fig. 93.

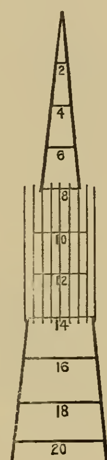
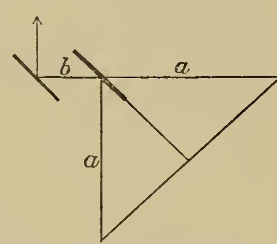


Fig. 94.



object beneath the Microscope. For the latter the author uses a micrometer scale with lines at distances of 1/10 mm. and 1/100 mm., and for the comparison object an isosceles triangle, with base 20 mm. and height 100 mm., printed on grey paper. It is easy to see how many micrometer divisions correspond to one of the triangle, thus in fig. 93, 4 mm. divisions fall on the No. 8 division which would correspond to a magnification of 20 times where the micrometer divisions are tenths. The proper magnifying power is then this number multiplied by the ratio of the distance $(a + b)$ of the object of comparison from the eye to 25 cm. (least distance of distinct vision). (Cf. fig. 94.)

BRADY, N.—**Illustrations of Diffraction.**

["My purpose this evening is to show by actual experiment how even a simply constructed Microscope may be made a most valuable instrument in examining the phenomena of this branch of Physical Optics, and to illustrate how cheaply and how easily many interesting diffraction experiments may be made."]

Paper read before the Western Microscopical Club, March 4th, 1889, 10 pp.

LIGHTON, W.—**Instantaneous Changes of Field.**

[Instantaneous changes from dark field to light field and back again with the largest numerical aperture possible.]

Amer. Mon. Micr. Journ., X. (1889) p. 164.

NELSON, E. M.—**Diatom Structure.**

Trans. Middlesex Nat. Hist. Soc., 1889, 13 pp. and 1 pl. of photomicrographs.

NELSON, E. M.—**On the Formation of Diatom Structure. II.**
Journ. Quek. Micr. Club, III. (1889) pp. 308–9 (1 pl.).
" " **An instrument for exhibiting the 1/2500 in. without a lens.**
Journ. Quek. Micr. Club, IV. (1889) pp. 20–1, 46–7.
NEUDORF, F., Jr.—**Charles Fasoldt Sr.'s Rulings.**
[Claim to have resolved 220,000 lines to the inch.]
The Microscope, IX. (1889) pp. 157–9.
Editorial Note, pp. 148–9.
See also *St. Louis Med. and Surg. Journ.*, LVI. (1889) pp. 289–90.
PETTIGREW, J. B.—**On the use of the Camera Lucida.**
Trans. Manchester Micr. Soc., 1888, pp. 80–3.
ROYSTON-PIGOTT, G. W.—**Microscopical Advances. XLVII.**
[Apochromatic Eidolic dots and Chromatic Beads.]
Engl. Mech., XLIX. (1889) p. 315–6 (3 figs.).
SMITH, T. F.—**On the Abbe Diffraction-plate.**
Journ. Quek. Micr. Club, IV. (1889) pp. 5–8.
THOMPSON, J. C.—**President's Address to the Liverpool Microscopical Society.**
[Deals largely with Prof. Abbe's theory of the Microscope, " the distinguishing feature of the microscopical science of the last twenty years."]
Journ. Liverpool Micr. Soc., I. (1889) pp. 1–24 (2 figs.).
WARD, R. H.—**Micrometry by the Camera Lucida.**
Queen's Micr. Bulletin, VI. (1889) p. 24.
WENHAM, F. H.—**Large Apertures in Microscopy.**
[Characteristic letter in reference to the old aperture controversy. "I have long since turned out or destroyed every paper or journal that contained matter relating to the subject."]
Engl. Mech., XLIX. (1889) pp. 438–9.

(6) Miscellaneous.

Celebration of the Third Centenary of the Invention of the Microscope.—The executive committee of the International Exhibition of Geographical, Commercial, and Industrial Botany, which will be held at Antwerp in 1890, have decided to celebrate the third centenary of " one of the most fruitful inventions of which science can boast, that of the Microscope."

With this object the committee propose to organize (1) a retrospective exhibition of the Microscope; (2) an exhibition of the instruments of all existing makers, of accessory apparatus, and of photomicrography.

A series of lectures, illustrated by the photo-electric Microscope will be given during the exhibition. They will include (1) the history of the Microscope; (2) the use of the Microscope; (3) the projection Microscope and photomicrography; (4) the microscopic structure of plants; (5) the microscopic structure of man and animals; (6) microbes; (7) the adulteration of alimentary substances, &c., &c.

It is intended to place the exhibition under the patronage of a " Comité d'honneur," which will be " composed of persons who have rendered the greatest services to microscopical science, and who hold the most honoured rank."

Cronin Mystery, the Microscope in the. *Amer. Mon. Micr. Journ.*, X. (1889) pp. 187–8.
Dallinger, Rev. W. H., an Interview with—Science and Christianity.
Quiver, 1889, pp. 351–5 (3 figs.).
DEBY, J., **Bibliotheca Debyana**, being a catalogue of books and abstracts relating to Natural Science, with special reference to Microscopy, in the Library of. (Vol. I. 1. Serial and Periodical Publications. 2. The Microscope and its Technicalities. 3. The Protozoa.) iv. and 151 pp. 8vo, London, 1889.
Fasoldt, Charles—Obituary Notices of. *The Microscope*, IX. (1889) pp. 173–4.
Queen's Micr. Bulletin, VI. (1889) p. 22.
St. Louis Med. and Surg. Journ., 1889, p. 366.

Laboratoires de Micrographie à l'Exposition universelle de 1889. (Microscopical Laboratories at the Paris Exhibition of 1889.)
Ann. de Micrographie, II. (1889) pp. 426–8, 483–5, 520–3.

MARTIN, N. H.—**A Plea for the Microscope, being the Annual Address delivered** before the North of England Microscopical Society by the President.
16 pp. 8vo, private circulation, 1889.

MASCART, M. E.—**Traité d'Optique.** (Treatise on Optics.)
[Microscopes, p. 137.] Vol. I., viii. and 638 pp. (199 figs.). 8vo, Paris, 1889.

PELLETAN, J.—**La Micrographie à l'Exposition universelle de 1889.** (Microscopy at the Universal Exhibition of 1889.)
Journ. de Micrographie, XIII. (1889) pp. 366–9, 403–7, 430–6, 464–7.

„ „ **[Distinction between "micrographes" and "microscopistes." English and American Microscopy compared with French and German.]**

["For the one the microscopic object is the subject of study, the Microscope is the means. . . . For the others the object is only the means, the subject of study is the Microscope itself."]

["In England and in America the Microscope is not in the same hands as with us. Whilst in France and in Germany the Microscope is only in the hands of professional scientists, and amateurs are rare, it is quite the contrary with the English, where the Microscope is much more common. The world of amateurs is there extremely numerous, fervent, and, it must be recognized, generally rich. These devotees of the Microscope form many powerful societies and clubs, and support numerous microscopical publications, often luxurious, always prosperous."]
Ibid., pp. 225–9, 321–6.

Royston-Pigott, the late Dr.—Obituary Notice.
Journ. of Microscopy, II. (1889) p. 254.
Engl. Mech., L. (1889) pp. 89–90.

SCHOTT—**Ueber Glasschmelzerei für optische und andere wissenschaftliche Zwecke.** (On glass-melting for optical and other scientific purposes.)
Central-Ztg. f. Opt. u. Mech., X. (1889) pp. 221–3 (1 fig.), 232–4 (1 fig.).
Cf. also *Queen's Micr. Bulletin*, VI. (1889) p. 15,
from 'Science of Photography'
and 'Ber. Vereins Förderung Gewerbfl.,' 1888, p. 162.

TYSON, J.—**Ignorance of the Microscope among Physicians.**
St. Louis Med. and Surg. Journ., LVI. (1889) pp. 368–9,
from 'Philadelphia Med. News.'

β. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture of Infusoria.†—M. E. Maupas recommends as damp chambers low flat-bottomed dishes with vertical sides, about 20 cm. in diameter. The dish is partly filled with fine well-washed sand, and in this are planted longitudinally two upright strips of glass, of such a height that the superior edge is 4 or 5 mm. below the level of the edge of the dish.

On these upright pieces as supports are placed three others, the middle one having a width of 4–5 cm., the two others 2 cm. only. It is on these three slips that are placed the slides bearing the infusoria. The whole is covered by a glass plate fitted as hermetically as possible to the edge of the dish. The dish being filled with rain-water up to the horizontal strips, the air-space is reduced to a layer of 4 or 5 mm. in thickness. This layer of air is always saturated with moisture, and the preparations suffer only an extremely feeble evaporation.

After each operation with a pipette, it should be washed with care, by forcing fresh water through it several times. Some infusoria have a strong adhesive power, and it often happens that they are left adhering

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. Zool. Expér. et Gén., xvi. (1888) p. 179.

to the internal surface of the tube; hence the importance of washing after each experiment.

In order to supply carnivorous species easily with food, it is necessary to find among the more common infusoria a species of small size that can be readily cultivated. *Cryptochilum nigricans* answers perfectly these conditions. It is herbivorous, and occurs everywhere in abundance. In order to utilize it as food for carnivorous species proceed as follows:—Prepare an infusion by cutting up a few pinches of hay in water, and heat the same for a few minutes to a temperature of 60° C. for the purpose of destroying strange species. Allow the infusion to stand two, three, or four days, according to temperature, until Schizomycetes have developed in it, then sow some *Cryptochila* in it, taking care not to introduce other species at the same time. The vessel containing the infusion should always be covered by a closely fitted plate of glass. The *Cryptochila*, finding abundance of food in the Schizomycetes, thrive and multiply by myriads. When the culture begins to decline, as it always will in regular course, it can be revived two or three times by adding crumbs of bread in small quantity. Too much bread causes acid fermentation, which destroys the infusoria. Instead of hay, pepper might be employed for these infusions, but it would be necessary to determine by experiment the quantity that could be safely mixed with a given volume of water. Too large quantities have been found to give infusions that checked the development of the infusoria.

Having thus obtained a well-stocked infusion, the mode of serving the *Cryptochila* to the carnivorous species isolated in the manner above described is as follows:—Place a drop of the infusion on a slide, and cover it with a cover-slip. It will then be seen that the *Cryptochila* collect round the edge of the cover, and in this position they are easily drawn into a pipette, and then delivered over to the carnivorous species. This mode of feeding enables one to make sure that no foreign species is introduced into the culture. Other species would undoubtedly serve the purpose of food as well as *Cryptochilum*—for example, *Colpidium colpoda*.

In the culture of herbivorous species, M. Maupas used boiled flour as food. A pinch of flour is placed in a sufficiently large quantity of rain-water, and boiled two or three minutes. With this pap one can easily supply the needs of *Paramæcium*, *Colpidium*, *Glaucoma*, *Vorticella*, and probably all species that ordinarily feed almost exclusively on Schizomycetes. This food is easily prepared, and is readily served by allowing it to flow in small quantity under the cover-slip of the preparation. It keeps only a short time, and hence must be renewed every day or two.*

FOSTER, R. A.—**Investigation of Bacteria by means of Cultivation.** *Amer. Mon. Micr. Journ.*, X. (1889) pp. 124–6.

FOUREUR, A.—**Étude sur la culture des microorganismes anaérobies.** (Culture of anaerobic micro-organisms.) 73 pp., 25 figs. 8vo, Paris, 1889.

JEFFRIES, J. A.—**A new method of making Anaerobic Cultures.** *Med. News*, 1889, pp. 347–8.

(2) Preparing Objects.

Preparing Eggs of Petromyzon.†—Dr. A. A. Böhm treats artificially fertilized eggs with Flemming's fluid, containing a larger admixture of osmic acid than is prescribed in the original formula.

* Amer. Nat., xxiii. (1889) pp. 277–9.
† Arch. f. Mikr. Anat., xxxii. (1889) pp. 634–5.

After thirty minutes the eggs are washed in distilled water, passed through 30 per cent. and 70 per cent. alcohol (three hours in each), preserved in 90 per cent., and cut in paraffin. The sections are fixed to the slide with albumen, stained with safranin, and mounted in xylol balsam.

Preparing and Mounting with Pressure Insects entire, as Transparent Objects.*—Mr. T. W. Starr adopts the following method:—

After procuring the insect, place it under a tumbler with a few drops of ether. When dead, wet it with alcohol, and place it in liquor potassæ, U.S.P., and let it soak until the skin is soft, and until, on slight pressure, the contents of the intestine can be pressed out through the natural or, if necessary, an artificial opening. This is best done under water in a white plate.

When this is effected the object is to be cleaned. Have a camel's hair brush in each hand; with one hold the object, and with the other brush every part of the insect on both sides. Float it on to a glass slide, and dispose each part in a natural position, either creeping or flying. Cover this with another glass slip of the same size, and press gently together, using only sufficient force to make it as thin as possible without crushing or destroying it. Confine the glasses, with the insect between them, with a fine brass wire, and place them in clean water, to remain twenty-four or thirty-six hours; this will give the insect a position that is not easily changed, and it is therefore proper that the position be such as you desire when the insect is finished. Remove the wire and open the glasses carefully under water, and float the insect off; give it another brushing, and let it remain a few hours to remove the potassa. Transfer it to a small but suitable vessel containing the strongest alcohol that can be obtained, pursuing the same course as with the water, placing the specimen between glass slips tied together, and let it remain about twenty-four hours.

Transfer to a vessel containing spirits of turpentine. It is to remain in this, kept between the glasses, until all the water is removed. While in the spirits of turpentine the insect is to be released several times, and the moisture removed from the glasses, and the insect again confined. When no moisture is seen to surround the insect, heat the glass slips containing the insect over a spirit-lamp until the contained turpentine nearly boils, when, if any moisture is present, it will show its presence when the glasses are cold.

If free from moisture it is ready for mounting. Float it on to a suitable glass from the turpentine, drop a sufficient quantity of balsam upon it, examine and see that no foreign substances are present, heat the cover slightly, and apply in the usual way. After a day or two heat the slide moderately, and press out the surplus balsam, and place a small weight upon the cover while drying. After the lapse of a suitable time remove the surplus balsam, and clean the slide.

In all the operations the utmost cleanliness is essential. The liquids should be frequently filtered and kept from dust, and a large share of patience will be found necessary.

After sufficient time has been given to allow the balsam to harden, so that the cleaning will not displace the cover, remove the surplus from around the cover-glass with a warm knife, and then moisten a soft tooth-

* Queen's Micr. Bull., vi. (1889) p. 29.

brush with a mixture of equal parts of alcohol and aqua ammoniæ, and a slight rubbing will clean the slide with very little danger.

After removing the superfluous balsam and cleaning the slide, finish by spinning a ring around the cover with a transparent cement.

Preparing Central Nervous System of Lumbricus.*—If the earthworm is to be sectioned *in toto*, it is necessary to remove the sand from the alimentary canal. For this purpose, place the worm in a glass cylinder partly filled with fine bits of wet filter-paper. As the paper is swallowed the sand is expelled, and at the end of about two days the alimentary tract is cleansed.

In the study of the ventral cord, Dr. B. Friedländer employed the following methods:—

Place the worm in water, to which a little chloroform has been added, and it soon becomes stupefied in an outstretched condition. Then cut open the body-wall along the median dorsal line, and pin the edges down in a dish covered with paraffin or wax. After removing the alimentary canal, the specimen may be treated with a preservative fluid.

1. Osmic acid 1 per cent. After an exposure of about half an hour, the worm is sufficiently stiffened to allow the pins to be removed, and it may then be cut into pieces of any desired length. The pieces are then left twenty-four hours in the same solution, then washed and passed through the usual grades of alcohol. Preparatory to imbedding in paraffin the pieces are saturated with chloroform or toluol. This method is excellent for the study of the neuroglia-like elements, and is the best for the brain.

2. Preparations treated thirty minutes with osmic acid (1 per cent.) are transferred to a dilute solution of pyroligneous acid (one part to three parts water), which reduces the osmic acid very quickly. This is followed by alcohol as before. The ganglion cells are well preserved.

3. The preparation is first treated with weak alcohol, then with stronger grades. After half an hour in 70 per cent. alcohol, it is stiff enough for removing the pins and for cutting into small pieces. Nerve-fibres are somewhat contracted by this method, and are thus more easily distinguished from the surrounding connective tissue.

4. Corrosive sublimate (aqueous sol.) and 50 per cent. alcohol in equal parts (thirty minutes) gave good preparations of the nerves and the neural tubes.

For preparations according to No. 3, the best stain is a modified form of Mayer's alcohol-carmine, absolute alcohol being substituted for 80 per cent. Sublimate preparations are successfully stained with Grenacher's hæmatoxylin. After half an hour in this staining-fluid, the preparations are transferred to acidulated alcohol (50 per cent., with a little hydrochloric acid) half a minute, then placed in alcohol containing a few drops of ammonia. Connective tissue and nerves are unstained, while ganglion cells are stained deep blue.

The last two methods of staining may be followed by picric acid, which stains the uncoloured elements yellow. The process is as follows:

After the sections have been fixed to the slide with collodion and the

* Zeitschr. f. Wiss. Zool., xlvii. (1888) p. 48.

paraffin dissolved with turpentine or xylol, the slide is placed in turpentine containing a few drops of a solution of picric acid in absolute alcohol. In a few seconds, nerve-fibres, connective tissue, and muscles are stained yellow. The slide is next to be placed in turpentine containing a few drops of alcohol, to wash away the excess of picric acid, then in pure turpentine or xylol preparatory to mounting in balsam.*

Preparing Sections of Spines of Echinus.†—Mr. J. D. Hyatt says that it is much easier to grind down a number of such sections at one time than to grind one singly, and he therefore fills a glass tube with spines, cementing them in place with balsam, and then by means of a circular diamond-saw slices both tube and contained spines into thin discs. A number of these discs are cemented by balsam to a glass slip, and all are ground down together. In order to successfully turn them over to continue the grinding, they are cemented to the first slip with thin balsam. The slip to which they are to be transferred is supplied with thick balsam and inverted over the sections, whereupon, with proper manipulation, the sections will leave the first slip and adhere to the second. He mounts seven or eight sections of spines under one cover, returning them to their desired positions, if displaced in mounting, by inserting under the cover a needle ground flat and very thin upon an emery wheel.

Examining a Shell-bark Hickory Bud.‡—Dr. H. Shimer writes:—Cut a longitudinal section near the middle (a somewhat thick section, 1/100 to 1/300 in., is easily cut), transfer it to a slide, apply glycerin with a brush; after it has pretty well soaked, drain off the superfluous fluid, warm the slide, apply glycerin-jelly, or better, the author's new mounting formula:—Glycerin-jelly, 1 part; Farrant's medium, 1 part; glycerin, 1 part, thoroughly mixed. Apply a heavy cover-glass, press it down a little, at length seal the edges with cement, and the result is a very beautiful specimen permanently mounted.

Examine it with a 1 in. objective, the stand being in the sunshine with a piece of sky-blue blotting-paper over the mirror for a background, and we have a more beautiful and instructive specimen than a 1/1000 in. section made in celloidin. The arrangement of the leaves and the hairs are all that could be desired. Even the cellular structure can be studied. This process is given, not to supersede other fine methods, but only as an easy method to aid in the study of a beautiful bud. If it is a side bud it will show the origin of the bud in the side of the limb and its progress to the surface.

White's Botanical Preparations.§—Mr. C. W. Smiley describes the botanical preparations of Mr. Walter White. Though not pretending to take the place of objects mounted in the usual way, yet, being inclosed in a transparent envelope, they are available for immediate examination, either without or with magnification, in many cases even with the higher powers of the Microscope.

* Amer. Nat., xxiii. (1889) pp. 189-90.
† Journ. New York Micr. Soc., v. (1889) p. 44.
‡ Amer. Mon. Micr. Journ., x. (1889) p. 104. See also p. 136.
§ T. c., pp. 110-1.

The following items from the catalogue will give some idea of the objects prepared:—

3. Orchid leaf. Fibro-spiral cells.
19. Yew. Isolated wood cells.
27. Brake fern. Scalariform vessels.
53. Pampas grass. Closed vascular bundles.
75. Mistletoe. Thickened cuticle cells.
99. Eucalyptus. Oil glands in leaf.
134. Begonia. Axile placentation.

In many cases the objects have been stained, either singly or doubly, and some stained three years ago have not faded. Their very low cost commends them to every student of biology or collector of microscopic objects.

They may be mounted in either resinous media (dammar, benzol-balsam), or glycerin or glycerin-jelly. Mr. White's instructions for mounting are as follows:—"Carefully separate the inclosing films, and remove the object. If for resinous media, soak in spirit of turpentine till clear, rinse in a fresh portion of the same, then drain, transfer to the cover or slide, and finish in the usual way. For glycerin:—If the object be oily, first wash out the oil with strong methylated spirit till clear, transfer to a mixture of glycerin and water, equal parts, in which let it remain an hour or two, then mount.

"Minute objects, such as isolated cells, should be transferred on the point of a scalpel to a slide (or cover), and separated with a needle in a drop of spirit; then, if for glycerin, mount while still moist; but if for resinous media, allow to dry, then moisten with a drop of turpentine before applying the medium. Spiral and other vessels, and long fibre cells, which mat together, should be soaked in a drop of weak spirit, and a few of the most perfect picked out under a simple lens."

Bacteriological Technique.*—Dr. C. Günther suggests that agar plate cultivations may be preserved on slides by cutting out a thin layer and then imbedding in glycerin. The specimen is to be mounted on the slide in the usual way.

The author also suggests that the condensation water of potato cultivation in test-tubes may be prevented from coming in contact with the potato by resting the latter upon a piece of glass tube about 2 cm. long. The latter lies on the bottom of the test-tube. In other respects the author advises Hueppe's technique.

Beck, J. D.—**A Slide of Hints and Suggestions.**
[Cleaning slides—How to dispose of excess of media on slides—Clipping covers—Centering and ringing clipped covers—Cements—Final cleaning of slides—Double-staining animal tissues—Pale copal varnish—Black elastic varnish—Aluminium palmitate copal varnish.]
The Microscope, IX. (1889) pp. 205–12.

Canfield, W. B.—**On the Microscopical Examination of Urinary Sediment.**
Queen's Micr. Bulletin, VI. (1889) p. 26.

Chadwick, H.—**Mounting Insects in Balsam without pressure.**
Queen's Micr. Bulletin, VI. (1889) pp. 31–2.

Dufour, L.—**Revue des travaux relatifs aux Méthodes de Technique publiés en 1888 et jusqu'en avril 1889.** (Review of the works relating to methods of Technique published in 1888 and down to April 1889.)
[1. Methods of preservation and culture. 2. Processes for treating the sections. 3. Microscopy. 4. Photomicrography. 5. Various.]
Revue Gén. de Botanique, I. (1889) pp. 280–92, 343–56 (4 figs.).

* Deutsch. Med. Wochenschr., 1889, No. 20.

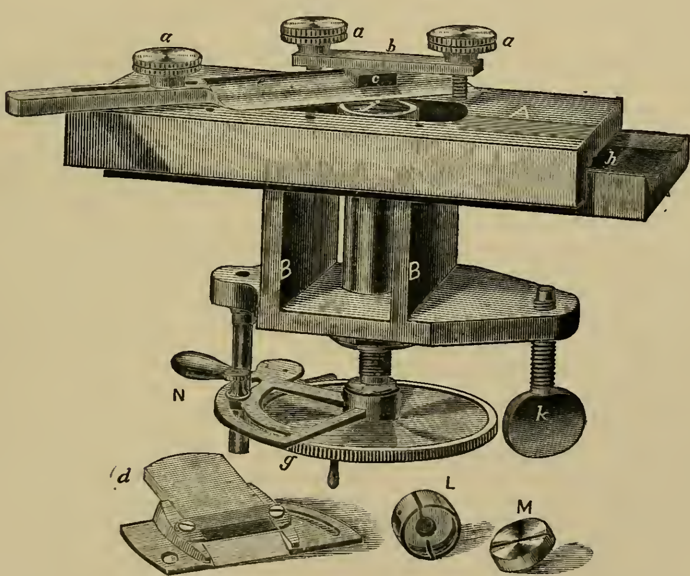
HALKYARD, E.—The Collection and Preparation of Foraminifera.
Trans. Manchester Micr. Soc., 1888, pp. 53–9 (1 pl.).
LATHAM, V. A.—Histology of the Teeth—Notes on Methods of Preparation.
Journ. of Microscopy, II. (1889) pp. 137–52.
RANVIER, L.—Traité technique d'histologie. (Treatise on histological technique.)
2nd ed., 870 pp. and 444 figs. 8vo, Paris, 1889.
ROGERS, F. A.—Preparation of Drug Sections for Microscopical Examination.
Queen's Micr. Bulletin, VI. (1889) pp. 12–3, from 'Rocky Mountain Druggist.'
TYAS, W. H.—Methods of Hardening, Imbedding, Cutting, and Staining Animal Sections, and Methods of Mounting the same.
Trans. Manchester Micr. Soc., 1888, pp. 83–5.
WHITELEGGE, T.—On Collecting, Cleaning, and Mounting Foraminifera.
Ibid., pp. 12–4.
„ „ Notes of a Method of killing Zoophytes and Rotifera.
[Chloroform and spirits.] *Ibid.*, pp. 14–5.

(3) Cutting, including Imbedding and Microtomes.

King's Microtome.*—Mr. J. D. King claims for his microtome no superiority over other first-class instruments for ordinary histological work in animal tissues, but it is designed especially for hard service in botanical work or for cutting any hard material, which requires absolute rigidity in the instrument.

The knife *e* is attached to a heavy nickel-plated iron carriage A, by a

FIG. 95.



steel clamp and shoe *b* and *c*, with milled-head screws *a*. The carriage runs on a solid iron track *h* and B, which is held to a table by clamp screw *k*.

For cutting very hard objects, like the wiry stems of plants or the

* The Microscope, ix. (1889) pp. 76–7 (1 fig.).

chitinous skeletons of insects, there is an attachment with a very stout blade, on the principle of a carpenter's plane *d*, which screws on to the carriage in place of the knife, and like the knife it can be used straight across or obliquely.

Diameter of well *j*, 7/8 in.; depth of well, 1¼ in.; depth of well with chuck L, 1 in.

For cutting soft material, paraffin may be cast directly into the well, or into a chuck (not shown) which is held firmly by being screwed into the bottom of the well. The adjustable chuck L is intended for harder material.

Microtome No. 1 gauges to 1/10,000 of an inch by turning the rachet *g* one click, but can be set to any desirable thickness less by the adjustable arc N. No. 2 gauges to 1/2000 inch, adjustable like No. 1.

Paoletti's Improved Microtome.*—In Sig. V. Paoletti's improved microtome the advantage aimed at consists in reducing the number of movements, and thus to diminish the tendency to inequality in the thickness of the sections. With this intent the knife is kept fixed, and the object-carrier alone moves. The microtome stand consists of a heavy cast-iron base, to which is fixed a vertical upright. To this latter is pivoted a largish steel plate at the end of two horizontal arms. To this plate is fixed the object-carrier, which receives horizontal and vertical movements from a micrometer screw placed beneath it, and with which it is connected by means of a special arrangement.

The knife is fixed by a clamp in any desired position to the vertical upright.

On a dial-plate, the index of which points against the steel plate, are marked numbers from 1–12; these correspond to hundredths of a millimetre, and serve to indicate how far the object-carrier ascends while it is moving horizontally at the same time.

Method for keeping Serial Sections in order during manipulation.†—Dr. L. Darkschewitsch has used the following method for four years for keeping sections of brain and cord in their proper order. A glass tube or wine-glass of the diameter of the sections to be cut is filled with spirit. Discs of filter-paper are also cut of the size to conveniently fit within the vessel. These paper slips are numbered, and having been arranged in their proper order, soaked in spirit. As the sections are made, the paper slip is laid thereon, the two drawn off together, and laid in the vessel, the paper side downwards.

When the vessel is full of the serially arranged sections, the whole series may be stained *in situ*. For this purpose the spirit is poured off, and, if necessary, the series is washed with distilled water before the staining solution is poured in. If Weigert's hæmatoxylin method is to be used, the solution is poured in after the spirit has been removed, and the glass vessel is then placed in a hot box for twenty-four hours. The staining solution is then poured off, and the series washed with distilled water until no more dye is given off. The sections are next taken out separately, and placed on a flat vessel (e. g. a plate) filled with the decolorizer, wherein they remain until the decoloration is complete. After having been thoroughly washed they are returned to the glass

* Atti della Società Toscana di Scienze Naturali, vi. (1888) p. 180.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 43–5.

vessel, where they are dehydrated with spirit. The rest of the treatment (clearing up and mounting in balsam) is done in the usual way.

Shimer, H.—**Section-cutting in the Cold.** *The Microscope*, IX. (1889) pp. 275–7.

(4) Staining and Injecting.

New Method of Staining the Flagella and Cilia of Micro-organisms.*—Prof. F. Loeffler has devised a new method for staining micro-organisms, and which is especially intended to demonstrate cilia and flagella. That the method is successful is shown by the results, and in photographs the flagella are perfectly seen, as also are cilia of infusoria and monads. The method essentially depends on submitting the preparations to the action of a mordant.

From previous experience it had been found that the capsule of pneumonia cocci were stained grey by ink. Hence tannate of iron suggested itself, and after many trials the author hit upon the following procedure which he pronounces to be satisfactory.

The mordant is prepared by adding a watery solution of iron sulphate to an aqueous 20 per cent. solution of tannin, until the whole fluid turns a black violet. To this fluid is then added 3–4 ccm. of logwood solution (1 part wood to 8 parts water). The solution should be kept in well-stoppered bottles and 4–5 ccm. of a 5 per cent. solution of carbolic acid added in order to keep it.

The staining fluid is made by adding 1 ccm. of a 1 per cent. hydrate of soda solution to 100 ccm. of anilin-oil water. This alkaline anilin water is then mixed with 4–5 g. of methyl-violet, methylen-blue, or fuchsin (solid) in a flask, and the ingredients mixed by shaking. When required the requisite quantity of fluid is filtered off.

The material to be examined must form a very thin layer upon the cover-glass; hence the fluid, &c., containing the bacteria must be diluted with distilled water, and from the solution the specimen taken, so that the film upon the cover is very thin.

After having been dried in the air and fixed in the flame, the mordant is poured over the film, and then the cover is held over the flame until the fluid begins to evaporate. The mordant is then washed off with distilled water, especial care being taken to remove all traces from the edge of the cover.

The next step is to filter a few drops of the stain (fuchsin best) upon the film. This is allowed to act for a few minutes and then the cover is very carefully warmed over the flame. As the fluid becomes warm the film darkens, and when it is of a black-red hue the stain is washed off with distilled water, and the preparation is then ready for microscopical examination.

Such is the principle of the author's method, but certain variations are also given. One of these is for showing delicate spirals in preparations of typhoid and potato bacilli. Here a few drops of acetic acid $1\frac{1}{2}$ per cent. are added to the solutions. It was also noticed that ferritannate gave more satisfactory results with these bacilli than ferrotannate, but with other bacteria, such as those of cholera, the reverse was the case.

* Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 209–24 (8 photos.).

Staining differences in resting and active Nuclei in Carcinoma, Adenoma, and Sarcoma.*—Dr. A. Kossinski who has been investigating the chromoleptic substances in cell-nuclei, comes to the conclusion that the resting nucleus is differently constructed from the active one. The author examined twenty different tumours, and pieces of these were hardened in sublimate solution or 97 per cent. alcohol, imbedded in paraffin and cut up into sections 0·01 mm. thick. Of the numerous stains used the preference is given to safranin and dahlia. The former was used in a 0·5 per cent. watery-spirituous solution; the latter in concentrated alcoholic solution. If, however, a double stain were used, a combination of hæmatoxylin with after-staining with safranin gave by far the best result. With this method the resting nuclei were coloured blue-violet, the karyokinetic or active nuclei a deep red. The method adopted was to stain the section which had been fixed on the slide for nearly a minute with the logwood solution: then to wash it with a 1 per cent. watery alum solution for two to four minutes, then with distilled water for three to five minutes, and lastly with alcohol for one to three minutes. The safranin solution was then allowed to act for twenty to thirty minutes, after which the excess was extracted with alcohol.

Other combinations such as nigrosin and safranin, indigo-carmine and safranin, and eosin or crocein with dahlia sometimes gave fair results.

Rapid method of Staining the Tubercle Bacillus in liquids and in tissues.†—This method, the invention of Dr. H. Martin, depends on the combination of heat and the proper dyes. The pigments used are crystal violet (hexamethyl violet) and eosin as a contrast stain. The stain is made in two solutions:—(1) Crystal violet, 1 g.; alcohol, 95 per cent., 30 ccm. (2) Carbonate of ammonia, 1 g.; distilled water, 100 ccm. Some of solution 2 is poured into a watch-glass, and so much of No. 1 added until the mixture stains filter-paper deeply. This solution is heated until it almost boils.

Cover-glass preparations put up in the usual way are stained in this solution for about one minute, and are then decolorized in 10 per cent. nitric acid (four to five seconds), washed in 95 per cent. spirit, dried or after-stained with the following solution:—Eosin, 1 g.; alcohol, 60 per cent., 100 ccm. This last stain only requires half a minute (cold). The staining of sections is the same as the foregoing, except that the author recommends that after alcohol the sections should be passed through oil of cloves, then turpentine and xylol. The solution of nitric acid should be 25 per cent. instead of 10 per cent.

Staining and Detection of Gonococci.‡—Dr. J. Schütz gives the following process for differential staining of gonococci:—Prepare the cover-glasses in the ordinary manner and immerse them for from five to ten minutes in a saturated solution of methyl-blue in a 5 per cent. aqueous solution of carbolic acid. Wash in distilled water and immerse for a few seconds in very dilute acetic acid (one minim of the acid to a drachm of water). Washing in distilled water completes the process, though if desired, a dilute solution of safranin may be employed as a

* Wratsch, 1888, Nos. 4, 5, 6. Cf. Zeitschr. f. Wiss. Mikr., vi. (1888) pp. 60–2.

† Annales de l'Institut Pasteur, 1889, p. 160.

‡ St. Louis Med. and Surg. Journ., lvii. (1889) p. 44, from 'Müncher Med. Wochenschrift,' 1889, No. 14.

complementary stain. Otherwise the gonococci will appear stained blue on a quite decolorized background.

Dr. F. L. James says * that this process differs in scarcely any degree from that which he has used for a long time for staining gonococci, and he has found it quite good. The ordinary alkaline solution of methyl-blue stains the gonococci a deeper blue than the surrounding tissues, and does not readily bleach out from the latter.

Simple and rapid Method of staining Bacillus tuberculosis in sputum.†—M. E. Dineur gives the following as being a very convenient method for clinical purposes for staining the tubercle bacillus:—

(1) Saturated alcoholic solution of fuchsin.
(2) 25 per cent. solution of carbolic acid in glycerin.
(3) Pure glycerin (or diluted with an equal quantity of water).
(4) Sulphuric acid, 1 in 5.

Several drops of sputum are placed in a watch-glass and then mixed with two or three drops of the fuchsin solution. A drop of the carbolated glycerin is then mixed up with the stained sputum. The mixture is then heated for several minutes to a temperature of 80°–100°. A piece the size of a pin's head is then removed with a needle to a drop of glycerin, placed on a slide, and the cover-glass imposed. A drop of the sulphuric acid is then run under the cover-glass. As the acid eats its way in, everything but bacilli are decolorized. These retain the stain sufficiently long to be easily recognized by microscopical examination made in the usual manner.

New Method for staining the Tubercle Bacillus.‡—Dr. K. A. Norderling has devised the following method, which he states is very safe and easy:—

The staining is done in the usual way by means of the Ehrlich fuchsin solution. The cover-glass is then washed in distilled water and afterwards immersed in a saturated solution of oxalic acid. It must remain therein until it is completely decolorized, when it is taken out, dried, and immersed in a weak solution of methylen-blue until it has received a light-blue colour (about one-half to two minutes). After this it is dried again and finally mounted in balsam. All is now coloured blue except the bacilli, which have a beautiful red colour.

Staining and mounting Elements which have been treated with Caustic Potash or Nitric Acid.§—At the Buffalo meeting of the American Society of Microscopists, a communication was read on this subject from Professor Simon H. Gage and Mrs. S. P. Gage. The main features of the technique of mounting histological elements which have been treated during the process of isolation with either nitric acid or potassium hydrate, is as follows:—

When nitric acid has been the agent in isolating the elements, the first step is to soak the latter in water, to remove all traces of free acid; then transfer to a slip of glass on which has been placed a drop of picrated glycerin. Separate or arrange the fibres, and remove excess of glycerin with blotting-paper. If desired to stain, place in Koch's red

* St. Louis Med. and Surg. Journ., lvii. (1889) p. 44, from 'Muncher Med. Wochenschrift,' 1889, No. 14.
† Bull. Soc. Belg. Micr., xv. (1889) pp. 59–62.
‡ Queen's Micr. Bulletin, vi. (1889) p. 21, from 'Medical Record.'
§ St. Louis Med. and Surg. Journ., lvii. (1889) p. 233.

tubercle bacillus stain (dilute), and leave for twelve hours, remove to a slip containing alcohol of 20°; replace latter by alcohol of 50°, and finally of 90°; clear, and fix with clove-oil collodion and mount in Canada balsam. If it is not desired to mount the object at once, it can be placed in saturated alum water after removal of the glycerin, afterwards stained with hæmatoxylin and mounted in any way desired.

Where caustic potash has been used as the isolating material the latter may be neutralized by the use of a 60 per cent. solution of acetate of potassium. There should be a plentiful supply of the neutralizing agent used, changing the charge two or three times. After pouring it off for the last time, wash with plenty of a saturated aqueous solution of alum, stain with alum carmine, or hæmatoxylin, and mount as desired.

Staining the Walls of Yeast-plant Cells.*—In demonstrating the two membranes of the cell of the yeast-plant, Prof. S. H. Vines found that, by first staining the cells in methyl-violet, washing in distilled water, and then transferring to anilin-green for some hours, in some instances the inner membrane appears of a violet colour, while the outer layer takes a slight green.

Solubility of Fat and Myelin in Turpentine Oil after the action of Osmic Acid.†—Prof. W. Flemming states that fat having been blackened with pure osmic acid never loses colour, even though exposed to direct sunlight for hours and afterwards treated with turpentine. This statement is made in consequence of a communication of M. C. Dekhuyzen, who found that preparations treated with Flemming's chrom-osmium-acetic acid mixture became decolorized when treated with turpentine oil or turpentine balsam. M. C. Dekhuyzen's explanation of the action is that turpentine oil acquires oxydizing properties by exposure to direct sunlight. This may or not be, but if the author's observations are correct it is obvious that the decoloration must be due to the association of the acetic or chromic acid.

Cole's (A. C.) New Slides.

["New method of staining tissues, and particularly nervous structures. This method is strikingly brought out by the slide showing sections of the lumbar and dorsal region of the human spinal cord in four colours. This new stain is particularly effective for photomicrography, as is proved by another slide mounting a transverse section of the left median human nerve. The other slides, mounted with the new staining, are very interesting:—Transverse section through the spinal cord and stomach of a snake, showing a semi-devoured lizard, and also section of the lizard's spinal cord; section through the cervical region of snake, showing spinal cord, œsophagus, &c.; and an effective mount (for microscopic purposes), giving vertical and horizontal sections of the human scalp, showing the hair-follicles, &c."]

Sci.-Gossip, 1889, p. 184.

Staining Tubercle-Bacilli. *Journ. of Microscopy*, II. (1889) pp. 165-6, from 'National Druggist.'

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

Hints on Mounting Objects in Farrant's Medium.‡—Mr. C. M. Vorce writes:—Attention is being turned again to this old but too much neglected medium, the preparation of which by all the published formulæ is attended with much trouble and vexation. The chief difficulty is in

* Journ. of Microscopy, 1888, p. 12.
† Zeitschr. f. Wiss. Mikr., vi. (1889) pp. 39-40.
‡ Amer. Mon. Micr. Journ., x. (1889) pp. 149-50.

filtering the viscous mass, for, notwithstanding the caution always given against stirring the mass to mix it thoroughly, in my own experience the bubbles formed in stirring have uniformly disappeared on long standing in a warm room. Air-bubbles in the completed mount, however, exhibit all the obstinacy with which they have been credited when the mass is prepared on the formula commonly given, viz. two parts each by weight of gum acacia and distilled water, and one part of glycerin. The gum is dissolved in the water, the glycerin added, the mass filtered, and a little camphor added to prevent mould. This makes a quite viscous mass which quickly dries around the edge of the cover, but from which air-bubbles cannot be driven out nor poked out if once imprisoned under the cover.

For such objects as are usually mounted in pure glycerin a much thinner preparation of Farrant's medium is very convenient, and is made by simply increasing the proportion of glycerin to gum. Another useful medium, which dries readily but shrinks more than the others, is made by taking by weight 6 parts gum, 4 parts white sugar, 16 parts water, and 6 parts glycerin, prepared as described. A still further modification is made by taking 8 parts gum, 4 parts white sugar, 2 parts gelatin, 20 parts water, and 12 parts glycerin. Dissolve the gelatin first, then add the gum and sugar, and lastly the glycerin. This mass never dries completely hard, but only to a tough, leathery consistence. In all cases a little gum camphor, phenol, clove-oil, or thymol should be added to the completed mass to prevent fungoid growth.

In the preparation of Farrant's medium on any formula, much time and annoyance may be saved by making the watery solution of gum, &c., much thinner than it is required to be, and after filtration evaporating it to the consistence desired, and then adding the glycerin. I always add to the water in the beginning an ounce or so of a weak solution of chloral hydrate, and add gum thymol to the finished mass; a piece the size of a large pin-head will do for an ounce of medium.

In mounting in any of these gum media, much trouble is saved by first macerating the object in some of the thin medium for a longer or shorter time according to its nature—longer for dense objects than for thin ones—and then arranging the object on the slip in some of the thin medium, allowing most of the water to evaporate (protected from dust), and then adding the thick medium and applying the cover, using a light spring clip to retain it in place. Air-bubbles will not be included by this method.

If a surplus of the medium was used so that much has escaped around the cover, this excess should be cleaned away within twenty-four hours after the cover was placed, while it is still soft and tough. If the cleaning is delayed until the mass outside the cover is hard, the cover will often be moved or pulled out of position by the removal of the outer mass. As soon as the partially cleaned slide has become quite dry, the slip should be placed on a turntable, and the slide cleaned close up to the cover, using a knife-blade or chisel-point to cut away the gum, and a moist rag or folded blotter to finish. Then add successive finishing rings of some resinous cement. Objects thus mounted will prove as durable as balsam mounts; there will be no shrinkage or distortion of soft parts, as often occurs with objects in glycerin; the most delicate and colourless of structural details are well shown, and the objects photograph extremely well.

Air-bubbles need not be included in the mounts, but if unfortunately present they may be removed by placing the slide in a beaker or glass vessel in which it can lie flat, putting in distilled water to cover the slide, and after standing a few minutes, place the vessel on a sand-bath, when the bubbles will soon emerge from under the cover and rise to the surface of the water. The slide is then to be carefully removed, wiped, and some of the thick medium spun round outside the edge of the cover, which will in drying fill the space under the cover without admitting any air. This is much better than to remove the cover or to try to poke out the bubble, as the removal or displacement of the cover is very likely to tangle up and destroy the object.

New Cell.*—Mr. C. H. H. Walker, of Liverpool, has devised a new cell for large mounts. They are rectangular in shape, and are made of one standard size, $1\frac{1}{4}$ in. by 5/16 in. They are also made with three sides only for use as live-troughs, &c. The thickness varies from 1/24 in. to 1/12 in. If a deeper cell be required, two or more can be cemented together.

Mounting in Fluosilicate of Soda.†—Mr. E. P. Quinn states that sodium fluosilicate, which is sold as a disinfectant under the name of Salufer, is a very good medium for preserving the green colouring matter of plants, and that owing to its slight solubility in water (0·4 parts in 100) it possesses the further advantage of causing little alteration in the shape of the cells.

The Bidwell Cabinet.‡—In this cabinet, the invention of Dr. W. D. Bidwell, "the drawers contain twelve slides each, and are made of a single piece of seasoned black walnut, $7\frac{1}{2}$ in. by 8 in. and 3/8 in. thick. The compartments are made with a 1-in. chisel, making six cuts 1/4 in. apart and 1/4 in. from the side on each side, and then cuts corresponding to these 3 in. towards the middle of the drawer. Then a piece is easily chipped out between each pair of cuts, leaving twelve drawers which easily hold the slides, separated down the centre by a ridge 3/4 to 1 in. wide. Taking a single cut with a gouge out of this ridge opposite each trough makes a convenient place to slip in the finger-nail to raise a slide. Then the drawers are complete, strong and firm, and very easily and cheaply made. Cut a shoulder on each side of the drawer, and a cabinet is made which will take less than half the time or expense to make of any other, and when done the slides are firmly held, each in its own compartment, and available for inspection or removal, and no danger of removing the cover-glass or label by hasty removal or the motion incident to carrying."

(6) Miscellaneous.

Microscopical Atlas of Bacteriology.§—Dr. C. Fraenkel and Dr. A. Pfeiffer are issuing in parts an atlas which is intended to show the microscopical appearances of micro-organisms. The illustrations have been reproduced from photomicrographs, and possess at the same time the faults and virtues of this process. The cover-glass preparations are shown under a magnification of 1000, and sections of 500. Colonies

* Sci.-Gossip, 1889, p. 184. † Trans. Manchester Micr. Soc., 1888, p. 75.
‡ Amer. Mon. Micr. Journ., x. (1889) pp. 184–5.
§ 'Mikroskopischer Atlas der Bakterienkunde,' 8vo, Berlin, 1889 (pls.).

from plate cultivations are represented under a low power, and those from test-tube cultivations of the natural size.

As the authors of the work are Koch's assistants, their work may be accepted as representing micro-organisms faithfully.

Detecting Alterations in Manuscripts.*—As an accessory to the use of the Microscope, photography is recommended by Mr. G. G. Rockwood. He has for years been in the habit of photographing manuscripts, models, books of accounts, cheques, and drafts, whenever their genuineness was questioned. The process sometimes makes legible figures, amendments, and alterations which even the Microscope does not fully bring out. This is due to the extreme sensitiveness of photographic plates to shades of colour. With the new "auto-chromatic" or colour-sensitive plates almost imperceptible stains on old yellow paper have been made clear and legible.

COCK, G. B.—**The Microscope in the Mill.** *Queen's Micr. Bulletin*, VI. (1889) p. 10.

* Amer. Mon. Micr. Journ., x. (1889) p. 126.

PROCEEDINGS OF THE SOCIETY.

The first Conversazione of the Session was held on the 28th November, 1888.

The following objects, &c., were exhibited:—

Mr. C. Baker:—(1) Portable Medical Microscope. (2) Zeiss's Apochromatic Objectives.

Messrs. R. and J. Beck:—(1) *Amphipleura pellucida*, with new 1/12 in. Oil-immersion Objective. (2) Circulation of Sap in leaf of *Vallisneria*, with 1/6 in. Binocular Objective.

Mr. Bolton:—*Limnias annulatus.*

Mr. Crisp:—Griffith Club Microscope with new fine-adjustment.

Mr. F. Fitch:—(1) Anatomy of Golden-banded Fly ♀. (2) Reproductive Organs of ♀ Earwig.

Mr. H. E. Freeman:—(1) Section of Eye of Tadpole. (2) Section of Flower of Horse Chestnut.

Mr. H. F. Hailes:—Longitudinal Section of *Fuselina* from Iowa, U.S.A.

Mr. J. D. Hardy:—(1) Nummulitic Limestone from the Pyramids. (2) *Eozoon canadense.*

Mr. J. Hood:—*Melicerta jairus* and *M. tubicolaria.*

Mr. S. W. Ireland:—(1) *Nodosaria scalaris* Batsch, var. *separans* Brady. (2) *Webbina clavata* J. & P., parasitic on grain of quartz.

Rev. T. S. King:—Insects in Amber.

Mr. R. T. Lewis:—(1) *Lecanium acuminatum.* (2) Living Larvæ of two species of Psychidæ from Natal.

Mr. R. Macer:—*Ciniflo atrox*, showing spinnerets of a living Spider.

Mr. S. J. M'Intire:—(1) Pupa of Cat Flea. (2) Section of Eye of Privet Moth.

Mr. G. E. Mainland:—*Braula cæca.* Parasite of the Hive Bee.

Mr. A. D. Michael:—Principal Ganglionic Chain and Proventriculus (Gizzard) of *Staphylinus* (Coleoptera), one of the very minute forms.

Mr. B. W. Priest:—Internal Casts of Foraminifera. Macassar Straits, 45 fathoms.

Messrs. A. Pringle and C. Lees Curties.—Photomicrographs of Bacteria, Physiological preparations, Diatoms, &c., exhibited with the Oxy-hydrogen Lantern.

Mr. C. Rousselet:—*Limnias cornuella*, a new Rotifer.

Mr. G. J. Smith:—(1) Olivine Dolerite, Glacial Drift, Finchley. (2) Basalt (columnar) with Olivine, Erpel, Linz, Rhine. (3) Micropegmatite. (4) Pikrite, Tringenstein. (5) The Fayette Meteorite, Bluff Settlement, Colorado River, Bluff Co., Texas. (6) Ejected blocks of Trachytic Lava from the Tuff of the Lacher See, Eifel, Prussia.

Mr. W. T. Suffolk:—Scale of *Morpho menelaus* mounted in oil of cassia.

Mr. J. J. Vezey:—Salivary glands of *Eristalis tenax.*

Messrs. Watson and Sons:—(1) *Amphipleura pellucida*, with 1/12 in. Apochromatic Objective by Reichert. (2) Tentacle of Sea Anemone (Actinia). (3) Trans. Section of Lamprey through region of Ovary, Kidneys, &c., double stained. (4) Long. Section of Vertebræ of Human Fœtus, two months, showing centres of ossification. (5) Group of Diatomaceæ; wheels of *Chirodota*, Butterfly scales, &c.

Mr. C. West:—(1) *Nodosaria consobrina* d'Orb. (2) *Cristellaria tenuis* Bornemann.

The second Conversazione of the Session was held on the 1st May, 1889.

The following objects, &c., were exhibited:—

Mr. J. Badcock:—*Lophopus cristallinus.*

Mr. C. Baker:—(1) Zeiss's new cheap Oil-immersion Objective 1/12 in. N.A. 1·20. (2) Zeiss's Apochromatic 8·0 mm. (1/3 in.). (3) Zeiss's Apochromatic 6·0 mm. (1/4 in.). (4) Nelson Model Microscopes. (5) Portable Binocular Microscope. (6) Portable Medical Microscope. (7) *Asterina gibbosa.* (8) Actinomycosis in tongue of Cow. (9) Zeiss's Apparatus for Monochromatic Light.

Dr. G. P. Bate:—(1) *Amphipleura pellucida*, with 1/16 in. (2) Podura scale with 1/16 in.

Messrs. R. and J. Beck:—(1) Human Spermatozoa showing filament. (2) Podura scale with 1/12 in. Oil-immersion.

Mr. W. A. Bevington:—*Planchonia fimbriata*, a new coccid from British Guiana.

Mr. Bolton:—(1) *Cristatella mucedo*, young stage. (2) Larvæ of *Leptophlebia marginata.*

Mr. W. G. Cocks:—(1) *Epistylis.* (2) *Stephanoceros Eichhornii.*

Mr. A. C. Cole:—(1) Section of Eye of Infant. (2) Ditto of Pike. (3) Series of sections of Snake which was killed soon after it had devoured a Lizard. Sections through the Lizard are seen in the stomach of the Snake, whilst the stomach of the Lizard is full of Insects, so little digested that the species are recognizable. (4) *Triceratium undulatum*, Oamaru.

Mr. E. Dadswell:—*Conochilus volvox.*

Mr. J. Deby:—(1) Microscope by Baker and Son, London. (2) Ditto by Chevalier, Paris. (3) Ditto by Oberhauser, Paris, 1838. (4) Ditto by Plössl, Vienna. (5) Ditto by Seibert, Wetzlar. (6) *Brugsmannia Lowii.* Stained sections of the ovary and stamens, exhibiting the gradual development of the male and female organs out of apparently homogeneous axial parenchyma. (7) Sponge spicules, the cavities of which are filled by a siliceous coloured core, supposed to have replaced the original living protoplasm.

Mr. F. Enock:—Slides showing life-history of the Hessian Fly, *Cecidomyia destructor.*

Mr. R. T. Lewis:—(1) Male of *Icerya purchasi* from Natal. (2) Spinous hairs on Larva sp. (?) from Natal.

Mr. R. Macer:—*Carchesium polypinum?*

Mr. G. E. Mainland:—(1) *Linyphia montana* ♂, Eggs and Pupal Organs. (2) *Walckenaera acuminata* ♀, Eyes on prominence.

Mr. E. M. Nelson:—Apparatus for exhibiting 1/2500 of an inch without a lens.

Mr. F. A. Parsons:—*Cordylophora lacustris.*

Messrs. Powell and Lealand:—*Amphipleura pellucida*, with 1/12 in.

Apochromatic Oil-immersion, N.A. 1·40, and Apochromatic Oil-immersion Condenser, N.A. 1·40.

Mr. B. W. Priest:—Polyzoa, &c., recent and fossil.

Messrs. A. Pringle and E. M. Nelson:—Photomicrographs of Bacteria, Physiological preparations, Diatoms, &c., exhibited with the Oxy-hydrogen Lantern.

Mr. C. Rousselet:—(1) *Notops brachionus.* (2) *Brachionus pala.* (3) *Brachionus argularis.* (4) *Triarthra longiseta*, &c.

Mr. G. J. Smith:—Basalt (Rowley Rag), with contemporaneous vein of more acid rock, Rowley, Staffordshire. Enstatite Diabase, Penmaenmawr. (2) Hornblende Porphyrite (altered Andesite), Old Red Sandstone conglomerate, Stonehaven, Scotland. Polarized light. (3) Olivin Dolerite, Knitellan, Scotland; fissures in Olivin filled with secondary Magnetite. (4) Pitchstone, Island of Ponza; in state of tension. Polarized light.

Mr. T. F. Smith:—(1) Abbe Diffraction Plate with central stops. (2) Photographs of Diatom structure.

Mr. W. T. Suffolk:—Circulation in *Anacharis alsinastrum.* Oil-immersion 1/12 in.

Mr. W. H. Tyas:—Series of Histological Slides prepared by Mounting Section of the Manchester Microscopical Society.

Mr. J. J. Vezey:—(1) Larva of *Echinus* (*Pluteus*). (2) *Arbacia pustulosa.*

Messrs. W. Watson and Sons:—(1) Pollen and sexual organs of Scarlet *Lychnis.* (2) Type slide of Diatoms from Simbirsk. (3) Kidney of Snail. (4) Meibomian glands in human eyelid. (5) Seed of Maize, showing Embryo, Endosperm, &c. (6) Tentacle of Cuttle-fish showing suckers in vertical section.

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AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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CONTENTS.

δ. Lamellibranchiata.

Molluscoida.

α. Tunicata.

β. Bryozoa.

Arthropoda.

α. Insecta.

γ. Prototracheata.

δ. Arachnida.

ε. Crustacea.

Vermes.

α. Annelida.

B. CRYPTOGAMIA.

MICROSCOPY.

α. Instruments, Accessories, &c.

(1) Stands.

(2) Eye-pieces and Objectives.

(5) Microscopical Optics and Manipulation.

(6) Miscellaneous.

β. Technique.

(2) Preparing Objects.

(3) Cutting, including Imbedding and Microtomes.

(4) Staining and Injecting.

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

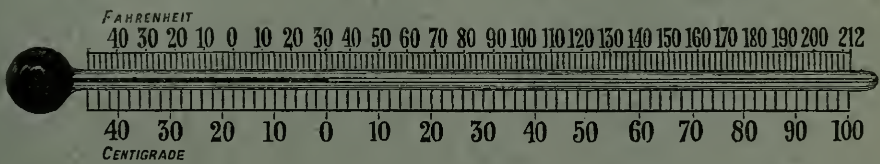
(6) Miscellaneous.

APERTURE TABLE.

Numerical Aperture. ($n \sin u = a$.)	Corresponding Angle ($2u$) for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. (a^2.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Air ($n = 1\cdot00$).	Water ($n = 1\cdot33$).	Homogeneous Immersion ($n = 1\cdot52$).	White Light. ($\lambda = 0\cdot5269\ \mu$, Line E.)	Monochromatic (Blue) Light. ($\lambda = 0\cdot4861\ \mu$, Line F.)	Photography. ($\lambda = 0\cdot4000\ \mu$, near Line h.)		
1·52	..	..	180° 0′	146,543	158,845	193,037	2·310	·658
1·51	..	..	166° 51′	145,579	157,800	191,767	2·280	·662
1·50	..	..	161° 23′	144,615	156,755	190,497	2·250	·667
1·49	..	..	157° 12′	143,651	155,710	189,227	2·220	·671
1·48	..	..	153° 39′	142,687	154,665	187,957	2·190	·676
1·47	..	..	150° 32′	141,723	153,620	186,687	2·161	·680
1·46	..	..	147° 42′	140,759	152,575	185,417	2·132	·685
1·45	..	..	145° 6′	139,795	151,530	184,147	2·103	·690
1·44	..	..	142° 39′	138,830	150,485	182,877	2·074	·694
1·43	..	..	140° 22′	137,866	149,440	181,607	2·045	·699
1·42	..	..	138° 12′	136,902	148,395	180,337	2·016	·704
1·41	..	..	136° 8′	135,938	147,350	179,067	1·988	·709
1·40	..	..	134° 10′	134,974	146,305	177,797	1·960	·714
1·39	..	..	132° 16′	134,010	145,260	176,527	1·932	·719
1·38	..	..	136° 26′	133,046	144,215	175,257	1·904	·725
1·37	..	..	128° 40′	132,082	143,170	173,987	1·877	·729
1·36	..	..	126° 58′	131,118	142,125	172,717	1·850	·735
1·35	..	..	125° 18′	130,154	141,080	171,447	1·823	·741
1·34	..	..	123° 40′	129,189	140,035	170,177	1·796	·746
1·33	..	180° 0′	122° 6′	128,225	138,989	168,907	1·769	·752
1·32	..	165° 56′	120° 33′	127,261	137,944	167,637	1·742	·758
1·30	..	155° 38′	117° 35′	125,333	135,854	165,097	1·690	·769
1·28	..	148° 42′	114° 44′	123,405	133,764	162,557	1·638	·781
1·26	..	142° 39′	111° 59′	121,477	131,674	160,017	1·588	·794
1·24	..	137° 36′	109° 20′	119,548	129,584	157,477	1·538	·806
1·22	..	133° 4′	106° 45′	117,620	127,494	154,937	1·488	·820
1·20	..	128° 55′	104° 15′	115,692	125,404	152,397	1·440	·833
1·18	..	125° 3′	101° 50′	113,764	123,314	149,857	1·392	·847
1·16	..	121° 26′	99° 29′	111,835	121,224	147,317	1·346	·862
1·14	..	118° 0′	97° 11′	109,907	119,134	144,777	1·300	·877
1·12	..	114° 44′	94° 55′	107,979	117,044	142,237	1·254	·893
1·10	..	111° 36′	92° 43′	106,051	114,954	139,698	1·210	·909
1·08	..	108° 36′	90° 34′	104,123	112,864	137,158	1·166	·926
1·06	..	105° 42′	88° 27′	102,195	110,774	134,618	1·124	·943
1·04	..	102° 53′	86° 21′	100,266	108,684	132,078	1·082	·962
1·02	..	100° 10′	84° 18′	98,338	106,593	129,538	1·040	·980
1·00	180° 0′	97° 31′	82° 17′	96,410	104,503	126,998	1·000	1·000
0·98	157° 2′	94° 56′	80° 17′	94,482	102,413	124,458	·960	1·020
0·96	147° 29′	92° 24′	78° 20′	92,554	100,323	121,918	·922	1·042
0·94	140° 6′	89° 56′	76° 24′	90,625	98,233	119,378	·884	1·064
0·92	133° 51′	87° 32′	74° 30′	88,697	96,143	116,838	·846	1·087
0·90	128° 19′	85° 10′	72° 36′	86,769	94,053	114,298	·810	1·111
0·88	123° 17′	82° 51′	70° 44′	84,841	91,963	111,758	·774	1·136
0·86	118° 38′	80° 34′	68° 54′	82,913	89,873	109,218	·740	1·163
0·84	114° 17′	78° 20′	67° 6′	80,984	87,783	106,678	·706	1·190
0·82	110° 10′	76° 8′	65° 18′	79,056	85,693	104,138	·672	1·220
0·80	106° 16′	73° 58′	63° 31′	77,128	83,603	101,598	·640	1·250
0·78	102° 31′	71° 49′	61° 45′	75,200	81,513	99,058	·608	1·282
0·76	98° 56′	69° 42′	60° 0′	73,272	79,423	96,518	·578	1·316
0·74	95° 28′	67° 37′	58° 16′	71,343	77,333	93,979	·548	1·351
0·72	92° 6′	65° 32′	56° 32′	69,415	75,242	91,439	·518	1·389
0·70	88° 51′	63° 31′	54° 50′	67,487	73,152	88,899	·490	1·429
0·68	85° 41′	61° 30′	53° 9′	65,559	71,062	86,359	·462	1·471
0·66	82° 36′	59° 30′	51° 28′	63,631	68,972	83,819	·436	1·515
0·64	79° 36′	57° 31′	49° 48′	61,702	66,882	81,279	·410	1·562
0·62	76° 38′	55° 34′	48° 9′	59,774	64,792	78,739	·384	1·613
0·60	73° 44′	53° 38′	46° 30′	57,846	62,702	76,199	·360	1·667
0·58	70° 54′	51° 42′	44° 51′	55,918	60,612	73,659	·336	1·724
0·56	68° 6′	49° 48′	43° 14′	53,990	58,522	71,119	·314	1·786
0·54	65° 22′	47° 54′	41° 37′	52,061	56,432	68,579	·292	1·852
0·52	62° 40′	46° 2′	40° 0′	50,133	54,342	66,039	·270	1·923
0·50	60° 0′	44° 10′	38° 24′	48,205	52,252	63,499	·250	2·000
0·45	53° 30′	39° 33′	34° 27′	43,385	47,026	57,149	·203	2·222
0·40	47° 9′	35° 0′	30° 31′	38,564	41,801	50,799	·160	2·500
0·35	40° 58′	30° 30′	26° 38′	33,744	36,576	44,449	·123	2·857
0·30	34° 56′	26° 4′	22° 46′	28,923	31,351	38,099	·090	3·333
0·25	28° 58′	21° 40′	18° 56′	24,103	26,126	31,749	·063	4·000
0·20	23° 4′	17° 18′	15° 7′	19,282	20,901	25,400	·040	5·000
0·15	17° 14′	12° 58′	11° 19′	14,462	15,676	19,050	·023	6·667
0·10	11° 29′	8° 38′	7° 34′	9,641	10,450	12,700	·010	10·000
0·05	5° 44′	4° 18′	3° 46′	4,821	5,225	6,350	·003	20·000

COMPARISON OF THE FAHRENHEIT AND CENTIGRADE THERMOMETERS.

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



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		°	£ s. d.					
100	4 inches	9	1 10 0	10	16	30	40	50
101	3 inches	7	1 10 0	15	24	45	60	75
102	3 inches	12	2 10 0					
103	2 inches	10	1 10 0	22	36	67	90	112
104	2 inches	17	2 10 0					
105	$1\frac{1}{2}$ inch	23	2 10 0	30	48	90	120	150
106	$\frac{2}{3}$ inch	25	2 0 0	70	112	210	280	350
107	$\frac{2}{3}$ inch	32	2 10 0					
108	$\frac{1}{2}$ inch	45	2 10 0	100	160	300	400	500
109	$\frac{4}{10}$ inch	65	4 0 0	125	200	375	500	625
110	$\frac{4}{10}$ inch	95	5 0 0	150	240	450	600	750
111	$\frac{1}{4}$ inch	75	3 10 0	200	320	600	800	1000
112	$\frac{1}{5}$ inch	120	4 10 0	250	400	750	1000	1250
113	$\frac{1}{8}$ inch	130	5 0 0	400	640	1200	1600	2000
114	$\frac{1}{10}$ imm.	180	5 5 0	500	800	1500	2000	2500
115	$\frac{1}{15}$ imm.	180	8 0 0	750	1200	2250	3000	3750
116	$\frac{1}{20}$ imm.	180	10 0 0	1000	1600	3000	4000	5000
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		°	£ s. d.			
150	3 inches	6	1 0 0	12	15	27
151	2 inches	8	1 0 0	18	23	41
152	1 inch	18	1 5 0	46	61	106
153	$\frac{1}{2}$ inch	38	1 5 0	90	116	205
154	$\frac{1}{4}$ inch	80	1 5 0	170	220	415
155	$\frac{1}{6}$ inch	110	2 5 0	250	330	630
156	$\frac{1}{8}$ inch	110	3 10 0	350	450	800
157	$\frac{1}{15}$ imm.	180	6 0 0	654	844	1500

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

DECEMBER 1889.

TRANSACTIONS OF THE SOCIETY.

XI.—*On the Effect of Illumination by means of Wide-angled Cones of Light.*

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

(*Read* 9*th October*, 1889.)

The diffraction theory leads to the following conclusions in regard to the mode of illumination in question.

(1) A wide-angled illuminating cone must be considered as composed of a multitude of (infinitely) narrow pencils, which have very different directions of incidence upon the object—from perpendicular incidence (the axial pencil) to a certain degree of obliquity, with all intermediate directions in gradual change.

(2) Provided the structure under observation admits of a perceptible diffraction-effect, every single (*i.e.* infinitely narrow) beam of incident light is "split-up" in its transmission through the structure, into the "diffraction-pencil" (or "fan") which is peculiar to the structure; and gives rise to a certain diffraction-spectrum at the back of the objective.

According as this elementary diffraction-fan of every incident ray has more or less angular extension, and according as the incident ray, to which it belongs, is more or less oblique—both these points considered with regard to the aperture of the objective—a smaller or greater part of such an elementary diffraction-spectrum is admitted to the objective, and utilized for the formation of the image.

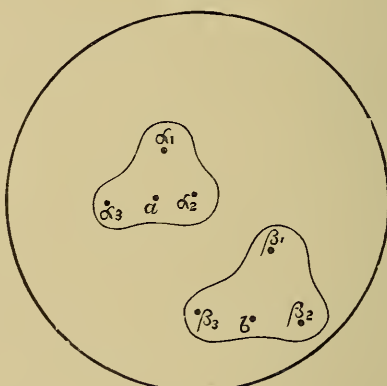
(3) In the case of a sufficiently wide-angled illuminating cone (at all events, when the incident light fills the whole aperture) the multitude of elementary diffraction-pencils, corresponding to the multitude of elementary incident rays, mingle together at the back of the preparation—and the diffraction-spectra at the back of the objective—overlapping one another to such an extent, that nothing else but white light, filling out the whole aperture, can be observed.

Nevertheless these various elementary diffraction-pencils, mingled together within the objective, produce images of the object quite separately; every single elementary pencil gives rise to its own image; the rays of different elementary pencils being unable to co-operate.

For the projection of an image is based on the re-collection (into one point) of an undulatory motion which is derived from one luminous point (one element of the original source of light). Rays which originate from different luminous centres (as is the case with diffracted rays appertaining to the diffraction-pencils of different incident beams) are incapable of interfering—the undulatory motions of those rays are quite independent of one another, "incoherent"; they cannot add their undulations according to the interference principle; but can add only their "vis viva," i. e. the intensity of illumination.

For explanation: In fig. 96 let (a, a_1, a_2 . . .) and (b, β_1, β_2 . . .) be the cross sections of the diffraction-pencils of any two different incident rays a, b, a_1, β_1, a_2, β_2 . . . denoting

Fig. 96.



corresponding diffracted rays within these pencils, or let the same be a representation of any two elementary spectra at the back of the objective, isolated (mentally) from the whole multitude: then only the rays from the group a, a_1, a_2 . . . act together by way of interference at the plane where the image is projected—and project such an image;—and also the rays emanating from b, β_1, β_2 . . . in the same way; but no ray of the first pencil unites with any one of the others.

Consequently, the image which is obtained by means of the wide illuminating cone is a mere superposition of a multitude of elementary images, produced quite separately by the various narrow beams; and this superposition consists of a mere addition of the quantities of light, which the various elementary images obtain at one point of the field, and does not involve an addition of the amplitudes of oscillatory motions according to the interference-principle (as is the case in the formation of every single elementary image).

(4) The elementary images produced by the various narrow

beams of which a wide incident cone is composed, are *dissimilar* images in general; and this for two reasons:—

(i.) Provided the diffraction effect of the structure is not confined to very small angles, the admission to the objective of pencils of *different obliquity* (i. e. pencils which result from incident rays of different obliquity) is different—or a different part of every elementary diffraction-fan is lost. That belonging to an axial incident beam is admitted in its central position, and a peripheral portion only is lost; that which belongs to an oblique ray is stopped off up to a full half, one from the left hand, another from the right. As the admission of different parts of the total diffraction pencils of a structure makes the images always different (at least in the more minute features), their different obliquity of incidence alone would be sufficient to make the resulting image a mixture of different (and, in general, differently dissimilar) images; and this will be so, even in the cases where the diffraction-effect itself (not considered the different mode of partial admission to the aperture) is the same for an axial and an oblique incident ray.

(ii.) But this diffraction effect by itself is not the same for rays of different obliquity, except with such structures as act solely by means of absorption of light (total or elective), i. e. with such structures the detail of which shows simply a difference of transparency of the elements. In all structures, the elements of which show at the same time difference of refraction (or of density), rays of different obliquity are subjected to different amounts of retardation during the transmission; and owing to this, the diffraction-pencils arising from incident rays of different obliquity are of unequal constitution. Theory and experiment show that the images, projected by means of two beams of different obliquity of a structure of that kind, may be very widely dissimilar, in such a degree that in one partial (elementary) image there is a maximum of light at the same point of the field where the other has a minimum, or darkness. The mixture of a variety of elementary images of that kind must, consequently, produce more or less confusion, or even total suppression of structural detail.

This is practically made use of with great success in the method of R. Koch of Berlin, in the observation of tinted preparations. He recommended, twelve years ago, the use of a wide-angled cone of light, in order to suppress in the image of a preparation all the elements which have no colour, and to enhance in that manner the image of the coloured elements. The latter ones act merely by absorption, and therefore give rise to equal diffraction spectra for rays of different obliquities; the former ones (the histological tissues, uncoloured) act merely by means of different refraction and different retardation of the transmitted light, and give rise to dissimilar diffraction-pencils and dissimilar elementary images, the mixture of which is obliteration.

(5) The result of this consideration is:—The resulting image, produced by means of a broad illuminating beam, is always a mixture of a multitude of partial images which are more or less different (and

dissimilar to the object itself). There is not the least rational ground —nor any experimental proof—for the expectation that this mixture should come nearer to a strictly correct projection of the object (be less dissimilar to the latter) than that image which is projected by means of a narrow axial illuminating pencil. This latter image has the most favourable conditions in regard to similarity to the object, because in its production nothing is lost of the diffraction-pencil but the peripheral portions (which in most cases are of relatively small intensity). All the other images with which it is mixed in the case of a wide-angled cone, are liable to greater dissimilarity, compared to a strictly true image, because they depend upon a more incomplete admission of the diffracted light. And it is against all rules of reasoning to assume that a mixture, or superposition, of a variety of images, all of which are more or less dissimilar to a true projection, should be less dissimilar than that constituent which is the least dissimilar one (whatever this one may be).

This conclusion is in no way in contradiction to the fact, that in many cases a broad illuminating pencil may exhibit indications of structure which remain occult to a narrow axial one, because oblique rays are in that respect more effective than the axial ray. The above discussion turns solely on the approach to perfect similarity of image and object.

SUMMARY

OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(*principally Invertebrata and Cryptogamia*),

MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

ZOOLOGY.

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

a. Embryology.†

Primitive Segmentation of Vertebrate Brain.‡—Mr. C. F. W. M'Clure considers that the primitive vertebrate brain consisted of a series of segments, similar to those found in the embryonic spinal cord, and that the encephalomeres probably held the same relation to the mesoblastic head-segments as the myelomeres do to their respective mesomeres, that is, they were intersomitic, the centre of each neuromere being opposite the space between two somites, and giving off a mixed nerve from the apex.

The region known as the encephalon is the result of a great differentiation and specialization of the anterior segments of this primitive structure. That differentiation first began and has been greatest in the most anterior segments, and this may account for the greater size of the folds in this region than in the hind-brain, in which less differentiation has taken place, and which, therefore, conforms more to the vertebrate type.

Origin of Blood of Vertebrates.§—Dr. H. E. Ziegler considers that, phylogenetically, the blood- and lymph-vascular-systems were derived from the primary cœlom; in ontogeny it may be seen that some of the first vessels to arise are parts of the primary cœlom, and are gradually shut off from it. The red blood-corpuscles arise ontogenetically from solid venous rudiments, and in histological regeneration they similarly arise from venous capillaries; the red blood-corpuscles, the specifically respiratory cells, belong both in origin and function to the blood-vascular-system; they do not arise from the white corpuscles in the blood, but have a similar origin with them, insomuch as they are derived from the histogenetic foundation of all the mesenchymatous tissues.

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

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

‡ Zool. Anzeig., xii. (1889) pp. 435-8.

§ Ber. Naturf. Gesell. Freiburg, iv. (1889) pp. 171-82.

Placenta of Inuus nemestrinus.*—Prof. W. Waldeyer is able to confirm Turner's statement as to the resemblance of the human and simious placenta; the spongy layer of *Inuus* is more like that of *Homo* than is that of *Macacus*. A continuous layer of endothelium is found on the placental surface of the decidua, and passes on one side into the fœtal villi, and on the other into the maternal placental vessels. The author shows that the chorion and villi have a double cellular investment, and that the blood in the intervillous spaces is of a normal character.

Placentation of the Dugong.†—Prof. Sir William Turner has had the opportunity of examining the placenta of the Dugong, and has added to, and in some points corrected, the observations of Harting, who stated that the placenta was diffused and non-deciduate. The author finds that should the placenta be non-deciduate, in the sense that the vascular part of the maternal mucous membrane is not shed, the placenta of the Dugong gives a new type, one which is both zonary and generally non-deciduate. The diffused character of the placenta in the specimen described by Harting was due to its comparatively early stage of development, for the villi had not as yet limited themselves to a definite zone.

Development of Placenta in Dog.‡—Dr. G. Heinricius gives an account of the growth of the placenta in the dog. The uterine mucous membrane includes two kinds of tubular glands—superficial crypts and long glands reaching to the muscular layer. With the entrance of the fertilized egg into the uterus, both crypts and long glands elongate and ramify. This is especially marked in the long glands which expand inferiorly into cyst-like spaces. When the fœtal ectoderm comes in contact with the uterine wall, the epithelium of the latter degenerates, and is apparently absorbed; fœtal villi grow into the connective tissue septa of the crypt-stratum; then the epithelial layer of crypts and glands also degenerates, and the villi come to be surrounded by a syncytium. The deep stratum of long glands remains unaltered, while the upper has been modified into the maternal placenta. The villi of the chorion consist of a gelatinous tissue surrounded by a simple epithelium very closely adherent to the maternal syncytium. Even when the embryo is only 1·5 cm. in length, there may be seen round each pole a pair of narrow zones, the "lateral blood-sinuses." When the epithelium of the chorion comes into contact with these, its cells contain blood-corpuscles, which suggests an important nutritive rôle. In the cystic enlargements of the long glands, great cellular activity sets in, "uterine milk," or plasmic secretion is formed, the villi eventually reach this, and when they do so, their epithelium becomes adaptively altered in order to utilize the special nutritive material.

Pro-amnion and Amnion in the Chick.§—Dr. T. W. Shore and Mr. J. W. Pickering find that there is a diblastic pro-amnion in the chick, of the same nature as that of mammals. It is bounded at the sides by the anterior vitelline veins, and so agrees with that of mammals. The sinus terminalis, unlike that of mammals, is venous. The headfold is formed by the forward growth of the head over the diblastic pro-amnion, and not by a folding-off from the blastoderm. The head, tail,

* SB. K. Preuss. Akad. Wiss., 1889, pp. 697–710.
† Proc. R. Soc. Edinb., xvi. (1889) pp. 264–5.
‡ SB. K. Preuss. Akad. Wiss., 1889, pp. 111–17.
§ Journ. of Anat. and Physiol., xxiv. (1889) pp. 1–21 (1 pl.).

and lateral amnion-fold are not formed by a rising up of the blastoderm round the embryo, but are determined by the growth of the embryo and its sinking towards the yolk-sac. In ontogeny the amnion owes its origin to purely mechanical causes, the most important of which are the weight of the embryo and the resistance of the zona in the presence of the active forces of growth. The pro-amnion in the chick disappears at about fifty hours' incubation, and subsequently contributes to the ventral part of the head-end of the true amnion and to the wall of the yolk-sac.

Fate of Amphibian Blastopore.*—Mr. T. H. Morgan, with Mr. E. C. Applegarth, has examined the eggs of *Amblystoma punctatum*, *Rana halecina*, and *Bufo lentiginosus*. Just before the disappearance of the hypoblast beneath the epiblast, the blastopore elongates in the direction of the primitive streak between the medullary folds. The anterior end of the blastopore is directly continuous with the primitive streak; except in the region of the blastopore the medullary folds are widely separated, but in it they almost unite, though at the posterior end a distinct opening remains visible. In the next stage the neural folds have met everywhere except at the posterior end, and at this point a cavity is left which seems from surface-views to remain permanently open. A complete set of longitudinal sections shows conclusively that, in *Amblystoma*, part of the blastopore becomes the anus; from a study of surface-views it was seen that the elongated blastopore must have been in part arched over by the closing walls of the neural tube. The question of any relation to the neurenteric canal next suggested itself; some sections were seen in which the neural tube dips in suddenly and becomes continuous with the cavity of the mesenteron, and it became evident that the elongated blastopore gives rise anteriorly to the neurenteric canal and posteriorly to the permanent anus, while it closes in the middle part. Such a condition is very transitory. In *Rana halecina* the blastopore closes and a new anus is formed by a downward extension of the mesenteron meeting the epiblast, and an opening appearing at the point of fusion.

The hypothesis has already been advanced that the anus as formed in frogs is an example of abbreviated development, and the author believes that a study of *Amblystoma* clearly indicates along what road such a process has gone. If, instead of the blastopore itself elongating and remaining open, the cells of its posterior wall should extend backwards, and subsequently should separate to form a new opening, a condition such as is found in the frog and toad would be reached, and would be merely an abbreviation of what takes place in *Amblystoma*. A study of this last-named form suggests that the neurenteric canal is that portion of the primitive blastopore which has been closed in or caught by the folding over of medullary folds. If this rising up of epiblast is a secondary phenomenon or an abbreviation of an earlier condition, we can see how by an elongation of the primitive blastopore its posterior part escaped from being shut in, and remained as the anus of the adult.

Penetration of Spermatozoa into Ova of Frog.†—M. J. Massart has shown that the spermatozoa of the frog are retained by the surfaces with which they come into contact, and that they seek to increase their surface of contact. Dewitz has observed somewhat analogous phenomena in the spermatozoa of the cockroach. Massart is able, however, to

* Circ. John Hopkins Univ., viii. (1889) pp. 31-2.
† Bull. Acad. R. Sci. Belg., xviii. (1889) pp. 215-20.

propose a more thorough explanation of the entrance of the spermatozoon. The jelly round the egg, swelling in contact with water, presents from the surface inwards more and more dense strata. The spermatozoon, once attracted to the ovum, tends to penetrate wholly in order to experience the contact over its whole surface, and that as long as it meets strata of increasing density. When the absorption of water by the jelly is complete, the attraction which the strata of increasing density exercised upon the spermatozoon ceases, and by this time a penetration has probably occurred. M. Massart experimented with various gelatinous substances, some of which worked as well as the jelly of the ova themselves.

Spermatogenesis during Inanition.*—Dr. V. Grandis has experimented with pigeons, and finds that a fast of a few days is sufficient to alter the production of spermatozoa. When fasting it probably happens that there is a cessation of the production of the elements which should be converted into nematosperms, and that those only continue to grow which have already begun to be developed. The new formation of cells which is observed after the twelfth day of inanition is not destined for the production of new nematosperms. During inanition spermatozoa die in the interior of the seminiferous canaliculi. The elements of which the testicle is composed break up when the loss of weight undergone by the fasting animal is more than 40 per cent.; it is probable that this alteration is effected to maintain the animal alive with the products which result from the reduction of the testicle. The constituent elements of the spermatic canaliculi which resist the effects of fasting are, in decreasing order, the spermatozoa, the elements of the central, and the elements of the median layer. The cells which are preserved longest have the character of those which line the walls of these canaliculi; this important fact shows that, although the testicle may be reduced to a third of its primitive dimensions, the elements which are capable of giving rise to all the others are the last to disappear.

β. Histology.†

Phenomena of Indirect Nuclear Fission in Investing Epithelia.‡—Dr. O. Barbacci finds that the phenomena of indirect nuclear fission persist completely in all the investing epithelia of the guinea-pig, rabbit, and dog. The intensity with which the regenerative processes are effected varies with the different organs to which the epithelium belongs, with different animals, and with different individuals. Of the three animals examined, the guinea-pig exhibits the most active processes of regeneration; the other two are much less, although about equally, active. The intensity with which the karyokinetic processes are developed in investing membranes exhibits a complete independence of the morphological characters of the epithelia themselves. There does not appear to be any constant relation between the activity with which regeneration is accomplished and the degree or quality of the function. Although it cannot be absolutely demonstrated, it is very probable that the phenomenon of indirect nuclear division, in investing epithelia, is not continuous but intermittent, and this less for reasons of space than for those of time.

* Arch. Ital. Biol., xii. (1889) pp. 215–22.
† This section is limited to papers relating to Cells and Fibres.
‡ Arch. Ital. Biol., xii. (1889) pp. 134–6.

Division and Degeneration of Giant-cells of Medulla of Bone.*—M. H. Demarbaix has investigated the history of myeloplaxes or giant-cells of the medulla of bone. He finds that during life, and for a short time after death, they consist of a vesicular nucleus, formed of a membrane, achromatic filaments, chromatic bodies, and a fluid or enchylema. Arnold's nuclei rich in chromatin do not exist during life; they appear a short time after death, and are the altered form of the nuclei seen during life. The alteration commences with a swelling of the chromatic bodies; the colourable part soon forms, on the inner face of the nucleus, a continuous layer, which thickens more and more, and ends by occupying the whole cavity of the nucleus. This change is quite independent of micro-organisms, and occurs some time before the similar alteration of the small cells of the medulla. Degenerated nuclei offer the same kind of resistance to decolorizing agents as do nuclei in kinesis; this appears to indicate that the chromatin has undergone a modification by which it becomes analogous to, if not identical with, the chromatin of karyokinetic figures. The phenomena which Arnold has described under the name of indirect division in the lymphatic cells of the medulla, the spleen, and the lymphatic ganglia, are also post-mortem changes.

Multiple kinetic division was normally observed in the myeloplaxes of all the animals examined by the author, and must therefore be regarded as a physiological process; the statement of Cornil that there is no binary division in the giant-cells is incorrect. Multiple kinetic division is the only well-established mode of division, and the proofs of direct division are capable of other interpretations, among which the hypothesis of phagocytosis must be taken into consideration.

In the normal state a certain number of cells present phenomena of retrograde development; these are of two kinds; in the first the nucleus is converted into a drop of homogeneous semi-liquid substance, which may further divide into a number of smaller drops, and these are sometimes expelled from the protoplasm; in the second method the protoplasm disappears rapidly; the colourable part of the nucleus forms on its inner surface a refractive, continuous, and homogeneous layer.

Comparative Study of Striated Muscle.†—Mr. W. A. Haswell comes to the conclusion that there are two principal types of striated muscle in the Animal Kingdom—the simple and the compound—which are not in any way genetically related to one another. Compound striated muscular fibres are found in their most primitive, as well as in a more highly developed, form in certain Polychæta, where they occur as the equivalents of bundles of simple non-striated fibres found in a corresponding situation in related forms. Each compound striated fibre is derived from a bundle of simple non-striated fibres. In its simplest form (in the pharynx of a species of *Syllis*) the compound striated fibre has only a single transverse network running through a zone of singly refracting substance situated at about the middle of the fibre, with two doubly refracting zones, one on either side of it. In a slightly higher stage two other transverse networks are added, one on either side of the middle one; in other species of *Syllis* the fibres present from half-a-dozen to twenty transverse networks. In *Syllis coruscans*, the species in which the fibres are most highly developed, they have all the essential

* La Cellule, v. (1889) pp. 27–57 (2 pls.).
† Quart. Journ. Micr. Sci., xxx. (1889) pp. 31–50 (2 pls.).

characteristics of the striated fibres of the Arthropoda, differing only in the greater coarseness of the fibrils and of the networks. The development of the primitively simple transverse network from intranuclear filaments of adjacent intrinsic nuclei of the non-striated fibres is rendered probable by the correspondence of the transverse band of nuclei with the transverse network, and the replacement of the former by the latter. The author proposes to deal with the simple type of striated muscular fibre in another memoir.

Growth of Transversely Striated Muscle.*—Dr. W. Felix has made some observations on the growth of transversely striated muscle, chiefly based on the study of human embryos.

He finds that the young muscular fibre is hollow, and that the time when it becomes solid is different for the same muscles in embryos of the same age and for different muscles in one and the same embryo. The nuclei lie in the central cavity (axial nuclei), in the transversely striated mantle-layer (mantle nuclei) and in the periphery of the fibre (contour nuclei). The transversely striated mantle of young muscular fibres is not complete, but often exhibits clefts of various lengths. The diameter of the several fibres of one muscle often varies considerably; it increases a great deal till the third month, between the third and fourth month there is a considerable fall, and then again a regular increase. From the middle of the third month till the end of fœtal life we find in each muscle fibres with multiplying nuclei arranged in series. These fibres fall into two groups. In the first the fibre possesses several rows of nuclei in its mantle layer, and the brightly coloured nuclei of the rows differ in form, size, and distance from one another. In the median part of the row they are closely packed and pressed into all possible forms; this is the site of the greatest growth-energy (and in all probability corresponds to the nerve-ending); away from this they are round, and then elongated. The fibres break up into daughter-fibres, each of which contains a row of nuclei. Around the fibre there is formed a sheath rich in nuclei and vessels; this appears before the formation of the rows, increases gradually in thickness, and becomes concentrically striated. With increasing growth the sheath disappears. Longitudinal division of fibres occurs not only in lately born infants, but also in later years of life.

The muscular fibres of the second group contain only one row of nuclei in the central cavity. The dark-coloured nuclei are arranged transversely, and differ little in size, form, or distance from one another. There is no spot of greatest growth-energy, and there are no relations to the nerves. Longitudinal division of the fibres has not been observed. These fibres are found in the muscles of embryos two or three months old. The rows of nuclei are found almost regularly at the ends of the fibres, and are the expression of an active increase in length. Parts of the fibres of the second group break up, and their products resemble the sarcoplasts of Margo and Paneth.

While the muscular system is being laid down new fibres of the embryonic type are constantly being formed. As soon as all the fibres are developed there is a pause in the increase of the number of fibres; this occurs in the third month. When increase begins again it is only

* Zeitschr. f. Wiss. Zool., xlviii. (1889) pp. 224–59 (2 pls.).

effected by longitudinal division of the fibres already present, and that appears to be henceforward the only method.

Fundamental Structure of Osseous Tissue.*—M. O. Van der Stricht has examined the fundamental structure of osseous tissue. He finds that it presents great analogies to hyaline cartilage so far as its texture and the arrangement of its histological elements are concerned. In cartilage the fibrils have a tendency to form plexuses, and this tendency is seen in the typical adult osseous tissue of long bones, at least in the peripheral and complemental lamellæ; it is less pronounced in the circummedullary lamellæ and in the Haversian systems; the tendency exists, in a pronounced form, in the tissue of the fœtal perichondrial bone and in that which enters into the composition of the cochlea.

In this last the fibrils and bundles of fibrils are grouped in such a way as to form a very finely fibrillated osseous substance surrounding the Haversian canals, while others form an alveolar system which is continuous across a wide extent of bone. The fibres and bundles of fibrils are very closely connected with the bone-cells, and are, so far, comparable to the intercapsular bundles of hyaline cartilage. These close relations are to be explained by the mode of origin of the osseous tissue; in its formation two kinds of cells probably take part; "fibrillogenous" connective cells giving rise to the fibrils, and osteoblasts to the calcareous deposits.

Structure of Protoplasm.†—Prof. O. Bütschli sums up his conclusions as to the vacuolar constitution of protoplasm which he has repeatedly emphasized in regard to *Amœbæ*, *Noctiluca*, marine Rhizopods, and Ciliata. He has mimicked this structure by a fine emulsion of soap with benzin and xylol. The vacuolar foam which results is very stable, remaining in one case unaltered for two months. Again, acting on a suggestion due to Quincke, he sought for fine foam which would remain persistent in water or aqueous solutions. He reduced sugar or salt to the finest powder, mixed it with some drops of old olive oil, and watched under a Microscope the behaviour of drops of the mixture when immersed in water. The water diffused into the oil, attracted by the crystal particles, and changed these into minute vacuoles of salt or sugar solution. In twenty-four hours the drops became milky white, and a fine vacuolar structure resulted; they were cleared with glycerin and studied. The optical appearance of a network, of knots, of granulations, of microsomata indeed was clearly exhibited. Moreover a fine limiting membrane, like that of many cells, was formed. Still better results were obtained by using finely pulverized potassium carbonate mixed with oil. The slight evolution of carbonic acid gas from the free fat acid aided in the process, and the mimic cells when slightly pressed showed streaming movements like those of *Amœba limax* or *Pelomyxa;* in one case the streaming lasted twenty-four hours, and after forty-eight hours was restored by increased temperature. Bütschli explains the physics of this interesting phenomenon, and emphasizes his conviction that such artificial cells really shed much light alike on the structure and behaviour of real organisms.

* Arch. de Biol., ix. (1889) pp. 27–53 (2 pls.).
† Verh. Nat.-Med. Ver. Heidelberg, iv. (1889) pp. 12.

γ. General.

Protoplasmic Movements and their Relation to Oxygen Pressure.* —Mr. J. Clarke has made a long series of experiments in order to ascertain the minimum pressure of oxygen necessary to restore the streaming, amœboid, and ciliary movements of protoplasm after they have come to rest in the absence of that gas. The minimum for the streaming movement in the plasmodia of *Myxomycetes*, and in the cells of hairs and other tissues was found to vary from 1 mm. to over 3 mm. With the vegetable cells the variation was much more extensive. The age of the cell, and the conditions under which it has been developed, influence to some extent the minimum oxygen pressure necessary to restore movement. The time taken by the protoplasm to recover its streaming movement is too short to be measured in cases where the conditions are favourable, but increases as the cell-wall thickens, or the cell ages, or as the length of time between the cessation of movement and the introduction of the necessary oxygen supply. After ciliary movement is arrested in any healthy infusorian by the absence of oxygen the organism soon begins to disintegrate. The introduction of an oxygen supply of about 1 mm. is sufficient to arrest disintegration and restore ciliary movement, provided the breaking-up has not proceeded too far. The growth of the plant, and the streaming of protoplasm in the active cells thereof appear to be parallel phenomena; streaming, or at least the power of very rapidly assuming the streaming movements, is possessed by the parenchyma and, probably, the phloem of plants so long as they continue to grow in an atmosphere of hydrogen. Inability on the part of the protoplasm to continue these movements, seems to be always associated with total cessation of growth.

Orientation of Animals towards Light.†—Herr J. Loeb has made some observations on "animal heliotropism," from which he concludes that the same luminous stimuli as we consider to produce sensations in ourselves affect all, and even the lowest eyeless animals, and this notwithstanding the great differences in the development of specific heliotropic organs. The differentiation of these organs has, therefore, been due to the fact that the laws of luminous stimulation remain unaltered. Their influence must be due to a fundamental peculiarity of living matter.

Orientation of Animals towards Gravity.‡—The same author discusses also the phenomena of "animal geotropism"; he thinks it highly probable that the muscular vibrations are of importance for orientation in space, but he proposes to extend his inquiries.

B. INVERTEBRATA.

Zoology of Victoria.§—The eighteenth decade of this work edited by Prof. M'Coy contains figures and descriptions of a number of Polyzoa, and of the Great Red King-Crab (*Pseudocarcinus gigas*). The male of this crab is much larger than the female, having a carapace nearly a foot in width, and is provided with immense powerful pincers. The descriptions of the Polyzoa are, as before, drawn up by Mr. M'Gillivray,

* Proc. Roy. Soc., xlvi. (1889) pp. 370-1.
† SB. Physik. Med. Gesell. Würzburg, 1888, pp. 1–5. ‡ T. c., pp. 5–10.
§ 'Prodromus of the Zoology of Victoria,' xviii. (1889) pp. 171–80.

and refer to, *inter alia*, *Tesseradoma magnirostris*, the zoarium of which is covered by a thick epitheca, on which the only mark seen is the tubular opening of the zoœcial pore; when the epitheca is removed, the surface is seen to be covered by large perforations, which, in old specimens, may be filled in, or even become tubercular from the heaping up of calcareous matter. *Flosculipora pygmæa* forms tufts about 1/12 in. high, and resembles a microscopic bouquet of flowers; it is attached to the zoœcia of *Catenicella*. Three species of a well-marked group, for which the name of *Craspedozoum* is proposed, are described; the genus is allied to *Flustra* and *Psiflustra*. *Rhabdozoum Wilsoni* forms small phytoid, branching tufts an inch or more in height. In addition to the radical fibres, there are a few hollow chitinous rods which arise from the sides of the shoots, are beautifully transparent, glassy, and strongly convoluted towards the summit.

Fresh-water Fauna of East Africa.*—Dr. A. F. Stuhlmann continues his account of the fresh-water fauna of East Africa.† He was much interested by a species of *Dero* which he found in the sexual stage, when the gills presented a different form to those of a-sexual individuals. A new species of *Aeolosoma* with red oil-drops was observed. Two new forms of leeches were seen, one of which was almost always ectoparasitic on *Ampullaria*. Females of a species of *Rhabditis* were very common. The fresh-water fauna of Quilimane does not differ essentially from that of Zanzibar; here again the greatest wealth of individuals was presented by the Cypridæ; Copepods were rare, but a new species of *Moina* suddenly appeared in enormous numbers in a *Protopterus* tank; males did not appear for ten days. Very large Ampullarias (*Lanistes*) were present everywhere; the tip of their shell is nearly always eaten off and covered by a thick network of Algæ, mud, and débris. Various species of Leeches were observed; of the Oligochæta *Dero* was very common; *Eudrilus*, *Digaster*, allies of *Titanus*, and *Acanthodrilus* were also seen. In one case *Conochilus volvox* appeared in enormous quantities. The author is certainly making many very interesting discoveries.

Mollusca.

French Malacology.‡—M. A. Locard has three contributions to our knowledge of the Mollusca of France; the first consists of a series of scattered notices on various marine species; the second is a monograph of the species of the family Buccinidæ; about fifty species are recognized as living on the French coasts, a few of which are new. In the third memoir the species of the genus *Pecten* are described; of these there are about thirty-five known forms. The author discusses the characters which seem to be of specific value. The relative position of the auricles, and the presence or absence of the byssal sinus are good characters for forming groups, but lose their importance when species are being discriminated.

Innervation of Osphradium of Mollusca.§—M. P. Pelseneer points out that the osphradium appears to differ from other sensory organs in not being innervated by the central ganglia; it is further removed from these than is the otocyst, and always seems to have relations with one

* SB. K. Preuss. Akad. Wiss., 1889, pp. 645–60. † *Ante*, p. 494.
‡ Ann. Soc. Linn. de Lyon, xxxii. (1886) pp. 191–263; xxxiii. (1887) pp. 17–127 (1 pl.); xxxiv. (1888) pp. 133–287. § Comptes Rendus, cix. (1889) pp. 533–4.

of the visceral ganglia. The osphradium may be more or less widely separated from the visceral ganglion with which it is connected, as in the Gastropoda, or quite close to it as in the Lamellibranchiata. The second arrangement is the better for testing whether the nerve-fibres which end in the osphradium arise from the visceral ganglion itself or from the cerebral ganglion. Transverse sections through the cephalic extremity of the visceral ganglion of *Mactra* show that some of the fibres of the cerebro-visceral connective do not penetrate into the visceral ganglion, but go outside it and directly to the osphradium, into which no nerve coming from the visceral ganglion passes. The osphradium, therefore, does not differ from the other sensory organs of the Mollusca in the origin of its nerve-supply.

α. Cephalopoda.

New Phenomenon of Cleavage in Ovum of Cephalopods.*—Mr. S. Watase has a preliminary communication on a curious phenomenon in the cleavage of the blastoderm of *Loligo pealii*. The ovum exhibits distinct bilateral symmetry. In some preparations the nuclei in the left half were found to be dividing, while those on the right side were at rest, and in others the phases of activity were reversed. The author has followed up the alternating phases of activity and rest in the two halves of the bilateral blastoderm, until 116 segments were formed. The phenomenon, whether pathological or normal, probably has some important bearing upon the problem of bilateral symmetry, and may possibly throw light on the bilateral symmetry of form and function in all its degrees of evolution.

β. Pteropoda.

Anatomy and Histology of Cymbuliopsis calceola.†—Mr. J. I. Peck has had the opportunity of making serial sections of this Pteropod. The muscular system is almost entirely limited to the regularly intercrossing separate bands that furnish the fin; the outer layers of these lie diagonally at the sides. Just within them there is a layer, the fibres of which pass from one edge of the fin across to the other in arcs of concentric circles. Still more deeply there is a layer of muscle-bands that radiate from the proboscis to the margin. Each edge of the proboscis is rolled outwards into two diverging folds that form a ciliated groove leading to the large mouth. This is devoid of any remnant of buccal armature or salivary glands; mucous secreting cells are abundant in the œsophagus; the "liver" does not open into the stomach by any proper duct, but by a single, wide, direct communication. The hermaphrodite gland almost completely envelopes the visceral mass; the accessory reproductive glands are large and much compressed into folds; the genital ducts are strongly pigmented and are ciliated throughout.

In addition to the parts of the nervous system already described for *Cymbulia* there is an additional commissure connecting the large pedal ganglia.

Systematic Position of Desmopterus papilio.‡—Prof. P. Pelseneer discusses the characters of this Pteropod lately described by Chun, and placed by him in a new family of the Gymnosomata. It appears that it

* Circ. John Hopkins Univ., viii. (1889) pp. 33–4. † T. c., pp. 32–3.
‡ Zool. Anzeig., xii. (1889) pp. 525–6.

is a well-marked Cymbulid which has lost its pseudoconch, and it differs from a Gymnosomatous Pteropod in the following characters:—It has a single pair of tentacles; the cerebral ganglia are on the sides of the œsophagus, and not dorsal or applied one to the other; the foot has not the characteristic horse-shoe shape, and there is a single hepatic duct. It belongs to the family of the Cymbuliidæ, because it has no shell and a deciduous pseudoconch; the head exhibits a ventral flexure, and the tentacles are symmetrical.

γ. Gastropoda.

Gastropoda and Scaphopoda of the West Indian Seas.*—Mr. W. H. Dall has issued the second part of his report on the Mollusca collected in the Gulf of Mexico. A large number of new species are described, and it is found that three families, the Pleurotomidæ, Ledidæ, and Dentaliidæ, furnish nearly 28 per cent. of the species of the abyssal fauna collected by the 'Blake.' Mr. Dall points out that the most important characteristic of abyssal life is that it, and it alone, exhibits a fauna in which the reciprocal struggle is nearly eliminated from the factors inducing variation and modification. There is no mimicry or sexual selection where all is dark. In the struggle for life of the abyssal animal he is pitted against the physical character of his environment, and not against his neighbour or the rest of the fauna. Hence we should have, and really do have, the process of evolution less obscured by complications in the abyssal fauna than is possible elsewhere. From a study of these animals in the light of their environment much may be hoped towards the elucidation of great questions in biology, and naturalists should strive to promote deep-sea dredging as essential to the progress of science. The rain of food from the sinking of weak or dead surface forms is unquestionable, and the supply must, in the nature of things as we know them, far exceed the demand. This is illustrated by the absence or disappearance of protective devices in deep-sea species. The genus most abundantly represented of all is *Mangilia*, which is devoid of an operculum, and the diminution in size and solidity of these protective appliances is marked in all the deep-sea Gastropods. Nearly all the species are carnivorous by hereditary tendency. Those which are not become so by necessity. The ornamentation of the shell in deep-sea Gastropods may be explained in some cases as providing buttresses for the strengthening of the fragile and delicate structures that bear them. Their strength has to be sought for in corrugations of their shell envelope. In the depths where every portion of the shell must be permeated by the surrounding element to equalize the external pressure, and where carbonic acid exerts its usual malign influence on the limy parts of all organisms, we find a protective epidermis developed in most unexpected places. This is the explanation of the fact that in characteristic abyssal animals we find those puzzling and remarkable counterparts of land and fresh-water species of totally diverse groups, which have astonished every student of the Mollusca who has seen them.

Variations of Cardium edule.†—Mr. W. Bateson has investigated in the Aral Sea and in Egyptian lagoons the variations of *Cardium*

* Bull. Mus. Comp. Zool. Camb., xviii. (1889) pp. 1–492 (21 pls.).
† Proc. Roy. Soc. Lond., xlvi. (1889) pp. 204–11.

edule which appear to be correlated with the conditions of life. He regards as the most important result the fact that the shells of each sample, whether it be from a separate lake or only from a particular level, have special characters, and are more like to each other than to the shells of one of the other lakes or of another level. Again, the shells which have lived under similar conditions, i. e. in very salt water, resemble each other, having the characters of thinness, light colours, small beaks, ribbing on the inside of the shell, and great relative length. Similarly, the shells from the two isolated and independent fresh-water lakes at Ramleh also present similar characters, viz. thickness, similar texture, and shape. It is to be noted that the resemblance between the cockle-shells from an Asiatic lagoon and those from Abu Kir becomes still more striking when it is remembered that their immediate ancestry is very different; the Asiatic shells had been living for many generations in the brackish water of the Aral Sea, and had already become a well-marked variety before being subjected to the new conditions, while those which are found in Abu Kir must clearly be the immediate descendants of animals of the type found in the Mediterranean. The author suggests that in so far as any variation (as, for example, that of texture) occurs universally among the shells of a given sample, it may be legitimately supposed that they are correlated to the conditions under which they lived. The terraces of Shumish Kul give an opportunity for the comparison of several distinct stages in the origin of a natural variation, which appears to be almost unique.

Luminous Phenomena in Pholas dactylus.*—M. R. Dubois has been much struck with the sensitiveness to light exhibited by the eyeless *Pholas dactylus*. The contractile warning apparatus is made up of muscular segments which are merely the continuation of the pigmented epithelial elements which form a continuous layer on the siphon, beneath the cuticle. The pigmented segment and the muscular segment together form the photomuscular element. This warning apparatus is in more or less direct relation to the sensory elements of the periphery. When a ray of light falls on the surface of the siphon ("photodermatic retina"), it traverses the cuticle and exercises its action on the protoplasm of the pigmented segments. The modifications caused by this luminous radiation also determine a contraction of the muscular segment. This contraction disturbs the peripheral nervous elements just as if the siphon had been excited mechanically by touching its surface, and provokes a reflex contraction analogous to that of the iris when a ray of light strikes the retina. The mechanism of vision is, therefore, reduced to a true tactile phenomenon.

The constituent elements of the organs of Panceri, in place of being covered by a refractive cuticle, carry vibratile cilia. They are formed of a calyciform epithelial segment which is directly continuous with a muscular segment, and make up the myophotogenic segment. In the fresh state the calyciform epithelial elements are filled with a substance which they extrude when excited; in the midst of these, in the mucus which has become phosphorescent, there are numerous migratory blood-cells and the *Bacterium pholas* which the author has already described.

The most striking point is the great resemblance in structure and function between the parts which perform the photodermatic function

* Comptes Rendus, cix. (1889) pp. 233–5.

and those for the photogenic function. The former, however, is provoked by luminous vibrations from without, while the latter has, as its final result, the emission of luminous radiations into the surrounding medium.

Nudibranchiate Mollusca of Plymouth Sound.*—Mr. W. Garstang enumerates twenty-four genera and thirty-six species of nudibranchiate Mollusca from Plymouth Sound. Among the valuable captures are two examples of *Idalia aspersa* and three of *Lomanotus*. The author has endeavoured to furnish facts regarding the life-conditions of this group. Evidence is rapidly accumulating to prove that, in it, colour, whether conspicuous or dull, has a very important value for the individual and the species. Some cases of what appear to be mimicry are reported. With regard to the bright colours of the papillæ of Aeolids the author suggests that, in addition to their main purpose of warning enemies of the presence of disagreeable qualities (e. g. nematocysts), there is another. The bright colours are confined to the papillæ which can be detached from the body with the greatest ease and are reformed to their full size in two or three days; this arrangement must be serviceable in directing the experimental attacks of young and inexperienced enemies to the non-vital papillæ, and away from the vital, inconspicuously coloured parts of the body.

Microscopic Anatomy of Dentalium.†—Prof. H. Fol considers that a genus which represents by itself a class of the Animal Kingdom always deserves close study, but we cannot, we fear, give him all the space which his detailed monograph demands.

The ectoderm forms a simple epithelium over all the free surface of *Dentalium*, but the thickness of the layer varies in different regions and with the condition of retraction or extension in which the parts are found; the cells are in some parts flattened, and in others cylindrical. As in Lamellibranchs, there are a number of cutaneous glands, all of which are unicellular, and of which there are two types, which are respectively distinguished as the hyaline and the granular glands.

It is probable that the glandular tissue plays a part in the formation of the shell, but this may not be its only function. All the ectoderm except that covered by the shell is ciliated. The epithelium of the digestive tract forms a single layer which is comparatively deep, for the cells are elongated in the perpendicular direction; some of the cells are ciliated and some glandular, but it is probable that all are ciliated when young. The ciliated cells present an interesting peculiarity which the author believes to be very common in the Animal Kingdom, though not so well marked as in *Dentalium*. The cilia are implanted in a layer which is more transparent than the subjacent part of the cell; when this transparent layer is closely examined, it is seen to be crossed by pale lines which appear to correspond exactly to the cilia. In the middle of each of these striæ there is to be seen, in preparations which have been treated with carmine after Grenacher's method, a small corpuscle coloured a deep red like the nucleus. Finally, the part of the cell which is situated between the nucleus and the transparent layer is traversed by striæ almost perpendicular to the surface, which seem to have a relation to the cilia. The author gives some details as to the structure of the radula and the parts connected with it. The liver is a collection of cæca

* Journ. Marine Biol. Assoc., i. (1889) pp. 173–98.

† Arch. Zool. Expér. et Gén., vii. (1889) pp. 91–148 (4 pls.).

which open into the stomach, and though the mucous membrane of these two organs strikingly differs, there is a gradual transition which makes it difficult to mark the boundary between them. The protoplasm of the hepatic cells has a spongy texture; in section there is revealed a system of large spaces, the trabeculæ of which are irregular in appearance.

No one has yet described the histology of the nerve-ganglia, the general arrangement of which has been so well explained by Lacaze-Duthiers. They are composed of large ganglionic cells, small ganglionic cells, and fibrillar tissue, all of which are regularly arranged. The two cerebral ganglia are really one ganglion subdivided by a constriction in the sagittal plane; the substance, which consists of large and small ganglionic cells, extends uninterruptedly from one ganglion to the other; the tissue with large ganglionic cells forms the cortical layer below and at the sides; that with small cells is found on the dorsal surface. The fibrillar substance, which corresponds to the white substance in the brain of Vertebrates, occupies the whole of the interior of the gauglia. In the pedal ganglia there is not the same distinction between the two kinds of ganglionic tissue; the whole of the cortical layer, except at the points of origin of the nerves, is formed by cells of medium size, and the whole of the interior is occupied by the fibrillar substance; the latter alone extends uninterruptedly from one ganglion to the other, and so we have really a pair of ganglia. The other ganglia do not, from the histological point of view, deserve their name; ganglionic cells are only scattered on their surface, and there is no continuous layer. The author enters into a good deal of detail in this portion of his memoir.

Histologically, all the muscular fibres of *Dentalium*, to whatever organ they belong, are of the same structure; they are very long fibres, oval or circular in section, and rendered more or less polyhedral by mutual pressure. They only vary in length; the very long fibres are found in the locomotor organs, and the shortest in the region of the intestine. The nucleus of the fibre is always excentric in position; the amount of granular sarcode which surrounds the nucleus, especially at its extremities, is reduced in the fibres of the adult to a scarcely perceptible minimum. The several muscular organs are fully described.

The blood of *Dentalium* is colourless, and contains nucleated cells which recall the white blood-corpuscles of Vertebrates. The statement of Lacaze-Duthiers that there is no heart is too absolute. Physiologically, it is true that *Dentalium* has no heart comparable to that which propels the blood in higher Molluscs, but, on the other hand, M. Fol shows that the "perianal sinus" is provided with muscles, which, from the morphological point of view, he cannot imagine any one refusing to regard as the homologue of the heart of other Molluscs. This circumanal sinus (as it had better be called) has a delicate wall formed by an epithelium with flattened and spread-out cells; externally to this there are ribbon-like muscular fibres which are generally arranged parallel to one another, and leave between them free spaces which are about four times as wide as a fibre. Most of the fibres are set longitudinally, but a few run across and make angles with the rest. The other sinuses do not seem to possess either muscles or a true endothelial layer, and such are true sinuses. In a transparent *Dentalium* the author has seen, under the Microscope, the contractions of the circumanal vessel. The question as to whether the simplicity of the cardiac arrangements of *Dentalium* is acquired (or degenerated) or primitive must as yet remain open.

The glandular epithelium of the kidney is distinguished, at first sight, from that of the liver by the wider and less elongated form of the cells which compose it; as in all the glands, these cells are arranged in a single layer; the texture of the protoplasm is reticulated or spongy in the region of the nucleus, while the apical part has a more complex and very variable structure. In each cell one sees one to three balls of a very granular substance, distinctly yellowish in colour; there may also be, though they are rarer, colourless bodies. The apical part of the cell is very fragile, and it is almost impossible to get really satisfactory sections; there do not appear to be cilia in the renal cells, for Lacaze-Duthiers, Plate, and the author have all failed to find them.

The gonads are exceedingly simple, being in the form of a longitudinal fascicle, which has on its lateral edges a number of dilatations; the sac has a delicate wall, and is, primarily, closed. There are no traces at all of hermaphroditism. The gonad of the adult contains cells in all stages of differentiation, but the transition is always made in the most simple and natural manner, "sans aucune de ces complications romanesques qu'il est de mode de trouver et de rendre incompréhensibles à l'aide d'une nomenclature qui varie à la fantaisie de chaque auteur." With regard to the vexed question of the presence of an efferent duct to the gonads, the author says that there is no doubt as to the existence of the excretory canal which Lacaze-Duthiers described as extending along the whole length of the gonad, but it is not a canal from the histological point of view; it is merely an excavation of the axial part of the gonad and its lobes, hollowed out in the genital products and quite devoid of any epithelial or cuticular membrane. The canal may be followed in a series of sections, but it can only be seen when the sexual products are on the point of maturity.

The author concludes with an account of the tentaculiform filaments, but does not find himself able to speak definitely of their morphology; he endorses, therefore, Lacaze-Duthiers' condemnation of the group-name, Cirribranchiata, which has been proposed for *Dentalium*, and states that he is in complete accord with that naturalist as to the systematic position of the genus.

δ. Lamellibranchiata.

Movements of Bivalve Mollusca.*—Mr. D. M'Alpine communicates some observations on the movements of the entire detached animal, and of detached ciliated parts of bivalve molluscs, viz. gills, mantle-lobes, labial palps, and foot; these studies were made on *Mytilus edulis*. He finds that the entire animal, when removed from the shell, moves, the movements being rotatory, and at an average of fifteen minutes per round; the power of movement was retained for twenty-one hours in one case and fifty and a half in another. Detached mantle-lobes, gills, labial palps, and foot, either entire or in parts, also move. These the author describes in some detail. The movements are not entirely due to the action of cilia, for muscular contraction plays a most important rôle in altering the shape and dimensions of the part, and in giving it outlines which enable it to get rid of obstacles or to make a more judicious use of its motive power. The ciliary and other activity of all these parts is stimulated by direct mechanical irritation. It appears that there is just

* Proc. R. Soc. Edinb., xv. (1887–8) pp. 173–204.

as much reason to recognize volition in the detached parts as in the ciliated Infusoria, from the fact that the direction of the moving pieces of the gill is so frequently changed as they pass from point to point on a moistened plate. In the common sea-mussel there is a latent power of independent movement in the entire animal, as well as in the detached parts, which has hitherto escaped notice.

Abranchiate Lamellibranchiata.*—Mr. W. H. Dall calls attention to his work on *Cuspidaria* and allied forms, which was ignored, he thinks, by M. P. Pelseneer.† Of this M. Pelseneer ‡ offers an explanation, and proceeds to discuss some other points raised by Mr. Dall. The latter had doubted whether the Belgian naturalist had really seen examples of *Lyonsiella* Sars and *Silenia* Smith, to which the answer is that the examples of *Lyonsiella* were named by Mr. Sars, and those of *Silenia* were the types. There cannot be, as Dall supposes, any progressive development of the gill from *Cuspidaria* to *Lyonsiella*, but the contrary, for the gill is a more archaic organ than the muscular septum. The septa of the Septibranchiata are not, as Dall says, delicate membranes, but thick muscular septa, and the spaces seen are not artifacts, but, as the plates in the 'Challenger' Report show, constant and symmetrical holes, with definite lips.

Molluscoida.

a. Tunicata.

Origin of Test-cells of Ascidians.§—Mr. T. H. Morgan has a preliminary notice of his investigations on this disputed question. Observations were very satisfactorily made on *Cynthia partita*. Ova and follicular cells, in their earliest condition, appear as nuclei in the flattened epithelial membrane which forms the wall of the oviduct. One of the nuclei enlarges, protoplasm is formed around it, and it becomes an ovum, around which some of the other nuclei arrange themselves. At the same time the surrounding nuclei collect protoplasm about themselves, and this spreads over the ovum; in the layer thus formed the follicular nuclei lie as in a syncytium. These follicular nuclei increase in number by division, and the peripheral zone of protoplasm widens; at certain places this zone next projects slightly into the yolk, and at the same time the follicular nuclei migrate into the projections. These plugs of protoplasm, with the contained nuclei, become gradually constricted off from the follicular zone and form the test-cells just within the follicle. The ovum, test-cells, and follicular cells are all homologous.

In *Clavellina* the young follicular nuclei remain on the outside of the protoplasmic zone; later, some of the nuclei migrate into the zone and the follicular membrane is formed in the centre of this protoplasmic ring; it encircles the egg, and test-cells become separated from follicle-cells.

β. Bryozoa.

Anatomy of Phoronis australis.‖—Dr. W. B. Benham has had an opportunity of studying the anatomy of this comparatively large species of *Phoronis*. The mouth is a wide, though compressed, funnel-shaped opening, the corners of which are continued as grooves between the

* Bull. Soc. Zool. France, xiii. (1888) pp. 207–9.
† This Journal, 1888, p. 564. ‡ Bull. Soc. Zool. France, xiv. (1889) pp. 111–3.
§ Circ. John Hopkins Univ., viii. (1889) p. 63.
‖ Quart. Journ. Micr. Sci., xxx. (1889) pp. 125–58 (4 pls.).

tentacles. The lophophore varies in shape in different species, and the tentacles vary in length. Each tentacle has an epidermis consisting of a single row of cells over the greater part of the surface, but on the inner surface it is two or three cells deep, and those of the outer layer here carry long cilia. Within the epidermis is a ring of tissue which forms the skeleton; this encloses a spacious cavity, which is continuous below with the cœlom. A nerve passes up each tentacle on its inner side. The tentacles are not united by a true membrane, as, for instance, in *Plumatella*, but are merely connected together by the trabeculæ of basement-tissue.

The pit at the base of the inner series of tentacles does not seem, as some authors have thought, to be sensory, but rather glandular. The epistome has not the appearance figured by Allman, whose representation conveys quite a wrong idea. Its dorsal surface is covered by a cubical epithelium, continuous with and similar to the surrounding epidermis; its oral surface agrees with the epithelium of the œsophagus, and consists of very elongated, narrow, columnar cells carrying cilia. At the base of these is seen nervous tissue.

The nervous system lies immediately below the epidermis; between the basement tissue and the epidermis there is a narrow layer of granular substance, which is not stained in borax-carmine; in this layer there are a few rounded nuclei belonging to small nerve-cells, and numerous delicate fibres crossing the granular substance from the overlying epidermal cells. This is the nerve-band; it follows the lophophore, passing all round the oral side of the animal, and curves round at the sides of the nephridial ridges, following the spiral course of the lophophore. From this band a nerve goes to each tentacle and nephridium. There is no concentration to form a ganglion anywhere. After giving some further details, the author describes the digestive system. The cœlom is divided into two very unequal cavities by a septum, the histological structure of which is of some interest. It consists of a nearly homogeneous dense matrix, sometimes fibrous, in which are imbedded small spindle-shaped cells with rounded nuclei. Here and there are larger and smaller spaces, lined by cells, which appear to place the supraseptal in communication with the infraseptal cavity.

After some observations on the vascular system, nephridia, and gonads, the author enumerates and defines the known species of *Phoronis*, and then passes to consider the relations of the genus to other animals. So far as the Brachiopoda are concerned, resemblances are certainly to be seen in the arrangement of the tentacles and the division of the cœlom into a visceral and a tentacular cavity, but detailed comparison of adults, of larvæ, of the modes of development, shows that there is no close relation between *Phoronis* and the Brachiopods. At first sight *Phoronis* has a great resemblance to the Polyzoa, but the differences in structure are very considerable. Thus *Phoronis* has a closed vascular system, and the Polyzoa have none; the Polyzoa have a subœsophageal ganglion, while the nervous system of *Phoronis* is in an embryonic condition. The gonads of *Phoronis* are unpaired, of the Polyzoa paired, and the mode of origin of the mesoblast is very different in the two groups. On the whole, this difficult form seems to stand nearest to the Sipunculids, especially in the developmental history, where there are many, some important, points of similarity. The arrangement of the alimentary canal is the same in both, and it has the dorsal flexure found in the trochosphere.

Arthropoda.

Origin of Malpighian Tubules in Arthropoda.*—Mr. F. E. Beddard points out that in a species of *Acanthodrilus* minute cæcal diverticula arise at irregular intervals from the gut. They are at first tubular in character, and are lined by an epithelium identical with that of the intestine; as they get further away from their point of opening into the intestine they lose their tubular character and become continuous with undoubted nephridial tubules, with a duct excavated in the substance of their cells; the tubules, which are at first intercellular, become afterwards intracellular; they are absolutely indistinguishable from the nephridia, and appear to join the general nephridial network of their segment. These nephridial appendages are branched and anastomose with one another, and they may certainly be compared to the anal nephridia of the Gephyrea. It is only necessary to limit their number and arrange them regularly to convert them into Malpighian tubules.

Eye of Decapod Crustaceans and Arachnids.†—Prof. J. Carrière makes a critical review of recent observations by Reichenbach, Patten, Kingsley, Bertkau, Mark, Parker, and Herrick, on the structure and development of Arthropod eyes. He does not commit himself in the meantime to definite conclusions, which he leads us, however, to expect from a forthcoming work.

α. Insecta.

Function of Palps in Insects.‡—Herr E. Wasmann cannot accept the conclusion of Plateau that the palps are useless to gnawing insects in the ingestion of food. The fact that the palps of such insects as are fed by others are reduced or completely aborted seems to show that the palps must play an important part when food is independently acquired. On this point the author enlarges with a good deal of detail. We can only suppose what the function of the palps is; it is probable that they seek for and test suitable food; in forms such as *Atemeles* or *Lomechusa*, which have a semiparasitic mode of life, the labial palps are reduced, while the maxillary palps are long and well developed.

Some Coleoptera regularly use their maxillary palps as fingers by means of which they push the morsel into the mouth, e. g. *Hydrophilus piceus;* this same species is unable to take in food when all its palps are removed, while others, as *Dytiscus marginalis*, take food with less care. If the antennæ of *D. marginalis* are removed, that insect can find food by means of its palps, but if they also are removed the creature will die of hunger.

Double Plexus of Nervures in Insects' Wings.§—Dr. H. A. Hagen gives a photograph of a split wing of *Aeschna heros.* The wings of any insect can be split before the membranes become closely connected; the period varies with the size of the object and the temperature on the day of development, but is rarely more than twenty-four hours. The necessary operation is very simple; the wing is cut off at its base and, under water, is blown out by means of a small tube, and is then cut along its hinder margin. It is spread out on paper or glass under water, and is then carefully dried.

* Ann. and Mag. Nat. Hist., iv. (1889) pp. 290-2.
† Biolog. Centralbl., ix. (1889) pp. 225-34.
‡ Biol. Centralbl., ix. (1889) pp. 303-8. § Zool. Anzeig., xii. (1889) pp. 377-8.

Structure and Phylogenetic Significance of Embryonic Abdominal Appendages in Insects.*—Prof. V. Graber remarks that there are two facts which seem to show that the present meropodous Insects are derived from forms that had appendages on all their trunk-segments. The first of these is the presence of appendages on all the segments of the lower apterous Insects, and the other is the presence of ventral abdominal appendages in the embryos of the most various kinds of Insects. It is, however, to be noted that these embryonic appendages often disappear before they have passed beyond an altogether indifferent stage, and that, therefore, they tell us nothing as to the nature of the structures which have disappeared; the appendages on the first segment lead us to suppose that they are the remains of myriopodiform legs. The ventral appendages in *Stenobothrus* have a large lumen, and the cells of their outer wall are of enormous size; the coagulation found on making sections seems to be partly, at least, secreted by cells of the ventral saccules which are not limited by any chitinous membrane; or, in other words, these appendages appear to be truly glandular. A number of the statements and arguments used by Cholodkowsky in his recent memoir are traversed.

Markings of Lepidoptera in the Genus Ornithoptera.†—Dr. C. Fickert has investigated this subject with great minuteness, comparing species with species, and variety with variety, in intricate details of shades and dimensions. He believes that the varieties and species can be arranged in a series so orderly, that the notion of fortuitous variation is excluded, and that of progressive constitutional growth, as emphasized by Eimer, confirmed. In *Ornithoptera priamus*, to which special attention is paid, the author finds a species in process of rapid phyletic progress. Some of its varieties—*O. arruana*, *richmondia*, *priamus*, and *lydius* are now constant; others, e. g. *O. pegasus*, are still very unstable in both sexes; while in others, e. g. *O. crœsus*, the males are constant, but the females are unstable. Specific change is like varietal, the directions in both are few and definite, separation in space has been of much importance, and the females conserve longest the original characteristics. The interesting fact is pointed out that the caterpillar stage may sometimes in its markings advance beyond what is attained by the adult butterfly, the progressive variability being in such cases apparently predominant in one phase of life. The paper affords interesting corroboration of Eimer's results.

Spermatogenesis in Lepidoptera.‡—Herr G. Platner finds (1) that the centrosoma of the spermatocyte forms the apical portion of the spermatozoon, (2) that the rest of the head is formed solely from the chromatin of the spermatide nucleus, and (3) that the accessory nuclear body arising from the substance of the nuclear spindle (in the spermatocyte) is modified as a sheath for the axial filament of the spermatozoon.

Following a now well-established terminology, Platner distinguishes —(1) the last generation of cells as spermatides, (2) the penultimate as spermatocytes of the second order, (3) the antepenultimate as spermatocytes of the first order, and (4) previous generations of cells as

* Biol. Centralbl., ix. (1889) pp. 355–63.
† Zool. Jahrb., iv. (1889) pp. 692–770 (3 pls.).
‡ Arch. Mikr. Anat., xxxiii. (1889) pp. 192–203 (1 pl.).

spermatogonia. The spermatocytes correspond to ova; the two divisions which they exhibit represent the extrusions of polar bodies. In both cases there is a reduction of the chromatin to one-fourth of the original quantity, and the second division follows on the heels of the first without an intervening resting stage. The author works out in detail the parallelism between ovum and spermatocyte, and points out that Weismann's distinction between the first and second polar body, should logically hold true also for the products of spermatocyte division. These, however, are all equal and similar. In regard to the formation of polar bodies, Platner notes that the ovum at the time of extruding the first polar body contains only the naked centrosoma without any trace of archoplasma. The latter appears for the first time on the origin of the polar radiations round each centrosoma, and its previous absence may perhaps explain the inequality of the division in the formation of the polar bodies. In addition to the above-mentioned parallelism between ovum and spermatocyte, one of the most interesting facts confirmed by Platner's research is the importance of the centrosoma as a cell-centre.

Habits of certain Borneo Butterflies.*—Mr. S. B. J. Skertchly finds that in the forest depths butterflies are rare, most delighting either in the sunshine, or flying where it is close at hand. It is not the case that a number of butterflies are to be found high overhead on the forest-tops; nowhere, even where trees were in flower, were butterflies seen in number, although other kinds of insects were not rare. The majority of butterflies still fly near the ground, and possibly all did so originally. In Borneo neither does heavy weather debar them, nor do flowering creepers attract them to fly high; "this seems to point, as many facts do, to butterflies being still as much terrestrial as aerial creatures."

In dealing with the habits of particular species, the author notes that, in some cases, the females woo the males, and in some cases are both wooer and chooser. As there seems to be so little relation between the habits, beauty, and numbers of the sexes, and the sex of the wooer, it is difficult to see why we should introduce the complex machinery of sexual selection to perform what the ordinary laws of evolution seem equally capable of carrying out. *Leptocircus curius* has the habit of pushing its proboscis into wet sand, taking long steady drinks, and pumping the water out astern in rhythmic squirts.

Odoriferous Glands of Blaps mortisaga.†—Prof. G. Gilson has examined the structure of the odoriferous glands of this Coleopteron, and of some other species. In *Blaps* the odoriferous apparatus is very well developed, and consists of cutaneous unicellular glands; these cells are so arranged as to form lobes which resemble glandular tubes, from which they essentially differ in that each cell has a special excretory tube. In each cell four parts can be distinguished; there is a radiated vesicle, a central ampulla, a delicate excretory tube, and a tube-sheath. The solid portions of these parts are intimately connected with the reticulum of the cytoplasm. The internal rays of the vesicle, and of the sheath are orderly, and strengthened by radial trabeculæ of the cytoplasm. The membrane of the vesicle, and those of the sheath, tube, and ampulla, are formations which are analogous to cellular and nucleated membranes,

* Ann. and Mag. Nat. Hist., iv. (1889) pp. 209–18.
† La Cellule, v. (1889) pp. 3–21 (1 pl.).

and are formed from the cytoplasm. The radiation of the reticulum has not necessarily its centre in the nucleus of the cell; very different cytoplasmic formations, such as the radiated vesicle, the sheath, and the excretory tube, may afford insertion for the greater number of the radial trabeculæ.

Glandular Structure on Abdomen of Embryos of Hemiptera.*—Mr. W. M. Wheeler describes on the first abdominal segment of embryos of *Cicada septemdecim* a pair of invaginate glandular structures apparently homologous with similar, but evaginate appendages on other insects. In relation to the latter, there has been much diversity of opinion, but the author's investigations on *Blatta* have convinced him that they are neither sensory nor branchial organs, but glands. So is it with the invaginations seen on *Cicada* and *Nepa*. The function of the apparently degenerate glands was probably odoriferous.

Life-history of Chermes.†—Herr N. Cholodkovsky has continued his observations on the life-history of *Chermes*. He finds that *C. strobi* has no relation to *C. coccineus*, but to a new and undescribed "species" which he names provisionally *C. sibiricus*. *C. coccineus* is found to wander from the pine to the white fir, and in the succeeding summer returns to the pine, where it lays the eggs which give rise to the black males and females. Another "species" which the author calls *C. lapponicus*, wanders, in St. Petersburg, on to the larch, and, therefore, is an ally of *C. hamadryas*. The author must be understood to use these new species merely for the purpose of better discrimination. Further details are promised.

Dr. L. Dreyfus‡ has a critical and destructive article on Prof. Blochmann's recent essay on the Cycle of Generations in *Chermes abietis*. For the details of the dispute, reference must be made to the original.

Hypodermis of Periplaneta.§—Dr. P. Mingazzini investigated the hypodermis of *Periplaneta orientalis* to see if Minchin was right in his conclusion that the dorsal hypodermis of the abdominal segments consisted of two strata of cells, the outer chitinogenous, and the lower ganglionic. There are indeed large inferior cells, but these are not nervous, but merely epithelial, derived from the outer layer, and greatly increased in size. They are apparently specialized glandular cells of the epidermis, branched in form, large in size, and segregated from the chitinogenous layer. As to a special gland discovered by Minchin on the dorsal intersegmental membrane of the sixth abdominal ring, its cells are quite homologous with those of the general stratum under discussion.

Malpighian Tubules of Libellula depressa.‖—Dr. A. B. Griffiths adds the dragon-fly to the number of animals in which he has found uric acid; it is to be found in the Malpighian tubes, in which no other ingredient could be detected.

γ. Prototracheata.

Brain of Peripatus.¶—M. G. Saint-Remy chiefly describes the internal structure of the brain of *Peripatus*, as Balfour's account is very

* Zool. Anzeig., xii. (1889) pp. 500–4. † T. c., pp. 387–91.
‡ Biol. Centralbl., ix. (1889) pp. 363–76.
§ Atti R. Accad. Lincei (Rend.), v. (1889) pp. 573–8.
‖ Proc. R. Soc. Edinb., xv. (1887–8) pp. 401–3.
¶ Comptes Rendus, cix. (1889) pp. 315–7.

incomplete. The neurilemma is a very thick, hyaline membrane, which almost always breaks away from sections, and so escaped the notice of Balfour. The cerebral cortex is almost completely made up of small cells which are very poor in protoplasm; some, almost reduced to their nuclei, form a considerable aggregation—the anterior ganglionic mass—in each half of the brain. The cephalic ganglion corresponds to the "protocerebrum" and "deutocerebrum" of Insects, but forms a very homogeneous whole. The author gives the name of optic lobe to a ganglionic region which, contrary to the description by Carrière of *P. edwardsi*, exists behind the retina. There is no true optic nerve, but a short pedicle of dotted substance traverses the cerebral cortex and passes at once into the eye. The two symmetrical regions whence the optic pedicles arise are connected by a commissure. The anterior medullary mass is large, ovoid, and formed of dotted substance; it sends forward into the anterior ganglionic mass some large ramifications, which divide there and receive the continuations of the small cells. The medullary mass appears to be connected with its homologue of the opposite side by a small commissural cord. The whole system reminds the author of the pedunculated body of Insects; there is a dorsal pad which resembles in its structure the stratified organ of the Araneida. The olfactory lobe is characterized by the presence of numerous spherical or ovoid olfactory glomeruli. The enigmatic appendage on the ventral surface of the brain is not stalked; its essential elements are elongated cells which differ from the nerve-cells, and bound an excentric lenticular space which is occupied by a mass of chitinous substance. There are no nerve-fibres, but elongated cells, which are probably destined to facilitate the nutrition of the organ, penetrate into the cerebral cortex.

δ. Arachnida.

Malpighian Tubes and "Hepatic Cells" of Araneina.*—Dr. A. B. Griffiths and Mr. A. Johnstone have examined the Malpighian tubes and hepatic cells of *Tegenaria domestica;* the secretion of the former was found to yield uric acid, which was found in combination with sodium; no urea, guanin, or calcium phosphate could be detected in the secretion. The chemical tests applied to the secretion of the so-called liver show that this organ in the Araneina is similar in its functions to the pancreas of the Vertebrata.

Anatomy of Atax ypsilophorus and A. Bonzi.†—Dr. P. Girod has examined the anatomy of these Hydrachnids, parasitic in *Anodonta* and *Unio.* There are three pairs of buccal glands; into the stomach there open two large lateral cæca and one larger superior or cephalic cæcum. The excretory organ lies dorsally to the stomach and is Y-shaped; there is no terminal intestine, and no anus; nor is there a cloaca common to the rectum and the excretory organ; the latter opens by a special pore.

In the dorsal wall of the pharynx there are large rounded cells, glandular in appearance; the independent buccal glands are formed of a delicate tunica propria and a single row of large cylindrical cells; the protoplasm of these is homogeneous, and the nucleus is well marked. The walls of the stomach and cæca are lined by a single layer of cells, some of which are parietal and some secretory: the former contain

* Proc. R. Soc. Edinb., xv. (1887–8) pp. 111–4.
† Bull. Soc. Zool. France, xiv. (1889) pp. 107–10.

greenish granulations and a large nucleus; they form groups of four cells, which alternate with the large secreting club-shaped cells. These are fixed to the wall by a filamentar extremity, and are supported by the neighbouring parietal cells; the free end dilates into an ovoid head, and is supported by its neighbours, the whole forming a villosity which projects into the cavity of the stomach. These giant-cells have a granular protoplasm and a large basal nucleus; in addition there are other masses in the interior, which vary with the cell under examination. Sometimes there is a rounded body staining with carmine, or the body may be larger and brownish; in other cases, there are two brownish globes which appear to be formed by the transverse division of a single body; and in other cases there is a rounded group of brownish spheres of which there may be as many as eight or ten. The excretory organ has its wall lined by a layer of pavement-cells, filled with fine yellowish granulations; these are set free by the breaking up of the cells, the débris and nuclei of which are found among the free granulations.

Halacaridæ.*—Dr. H. Lohman has a monographic memoir on these marine Arachnids. After detailing the history of our knowledge of the group, the author discusses its morphological and anatomical characters, and its systematic position; a convenient table is given, in which the form of the body, the skeleton of the body, of the legs, and of the capitulum, and other anatomical characteristics are enumerated under the Prostigmata, peculiarities common to the Trombidiidæ, Hydrachnida, and Halacaridæ, peculiarities special to the Halacaridæ, peculiarities which they have in common with the Hydrachnida, and those that they have with the Trombidiidæ. The conclusion arrived at is that the Halacaridæ form a subfamily of the Prostigmata allied to the Hydrachnida.

In the systematic portion the subfamily is defined, and the group divided into four genera, of which *Aletes* and *Agaue* are new, the two others being *Halacarus* and *Leptognathus*. The genera and species are next systematically described; of the latter there are twenty, ten of which are new.

In the fourth division of his memoir the author deals with biological results; these are treated of under the heads of distribution, and peculiarities of mode of life; the latter is divided into: relation to external influences, where we note that these creatures have a remarkable want of sensitiveness towards cold; movements of the animals; and relation to other plants and animals. In the fifth part the ova and the developmental stages are described; there is a remarkable resemblance between the larvæ and the imagines.

Structure and Development of Eye of Limulus.†—Mr. S. Watase has a preliminary notice on this subject. When he compares his results with those of Lankester and Bourne, he finds that they seem to have overlooked the existence of one large ganglion cell in the centre of each ommatidium of the lateral eyes, which, in the author's opinion, is the most important morphological element. By using the depigmenting process they failed to make out the important differentiation into the pigmented and non-pigmented parts existing in each rod-bearing cell, or in the retinula. What they have called the intrusive connective tissue

* Zool. Jahrb., iv. (1889) pp. 269-408 (3 pls.).
† Circ. John Hopkins Univ., viii. (1889) pp. 34-7.

cells in the lateral eyes are the exceedingly elongated ectodermic cells, each with its own nucleus, which closely indent the outer parts of the rod-bearing cells. The entire structure of such elongated cells can only be brought out by maceration of the retina, for sections are necessarily misleading. The similarly named cells in the median eyes are also five ectodermic cells not derived by secondary migration from the mesoderm. The number of retinula-cells in the ommatidia of the lateral eyes is not constant, but very variable. The axial cavity inclosed by the rods, and by the rhabdom, is not empty, but is occupied by the axial process of the central ganglion cell.

ε. Crustacea.

Senses and Habits of Crustacea.*—Mr. W. Bateson, in the course of his investigations on the perceptions of fishes, has made some interesting by-observations on Crustacea. All in the tanks at the Plymouth laboratory, except *Carcinus mænas* and *Portunus depurator*, are more active by night than day, and many rarely come out by day at all. Excepting the shrimps, nearly all the individuals of the other forms observed have each its place to which it retires when morning comes, and in which it remains during the whole day. To the shrimp it is of paramount importance to know the difference between night and day, for it is not safe for it to hunt till darkness comes. Strangely enough it seems that this knowledge is not obtained by the eyes, or at all events not entirely through them, for there is no observable difference when the eyes are extirpated. Prawns, shrimps, and others find their food almost exclusively by scent, but they do not seem to have a very accurate knowledge of the direotion of it; it is not even certain that they can see each other. In some cases the eyes were observed to be particularly sensitive to shadows. Though it seems probable that the sense of smell is by the antennules in shrimps, at any rate, it is not exclusively so, for a shrimp with no antennules will hunt if a piece of worm be put very near it.

A very interesting description is given of the method by which certain crabs fasten pieces of weed and so on to their backs and appendages. The crab takes a piece of weed in his two chelæ, and neither snatching nor biting it, deliberately tears it across as a man tears paper with his hands. He then puts one end of it in his mouth, and, after chewing it up presumably to soften it, takes it out and rubs it finely on his head and legs until it is caught by the peculiar curved hairs which cover them. The whole proceeding is most human and purposeful. The various substances used are nearly always symmetrically placed on corresponding parts of the body. Curiously enough not only are all these complicated processes gone through by night as well as by day, but a *Stenorhynchus* cleaned and deprived of sight will immediately begin to clothe itself again with the same care and precision as before.

Function of Spines of Crustacean Zoœæ.†—Mr. W. F. R. Weldon, by comparing the behaviour of such zoœæ as have long spines and of those that are devoid of them, has been led to suggest a function for these organs. A larva that has them swims in an absolutely straight line towards the light, moving with great rapidity, and neither changing direction nor losing equilibrium during a journey of several feet. Larvæ

* Journ. Marine Biol. Assoc., i. (1889) pp. 211–4. † T. c., pp. 169–70 (1 pl.).

without spines move towards the light in a very different manner; all forward movement is spiral and so indirect, and is frequently impeded by somersaults, which appear to be involuntary; after each of these the zoœa will hang for a moment vertically in the water, as if to recover its sense of direction.

Cœlom and Nephridia of Palæmon serratus.*—Mr. W. F. R. Weldon commenced his investigations into the cœlom and nephridia of *Palæmon serratus* by an attempt to repeat the experiments on secretion recently described by Kowalevsky; † the colouring matter is taken up by the cœlomic and nephridial cells. If a prawn so stained be dissected in strong alcohol, it will be seen that a blue area in the thorax is connected by a deeply stained band of tissue with each nephridium; the blue area in the thorax is a sac which contains a clear fluid that is not blood; at its anterior extremity this sac gives off a pair of tubular processes, one on each side, each of which passes downwards to open into the urinary bladder of its own side. At its hinder end this sac is in close contact with the gonad; in other words, it is precisely similar in all its relations to the cœlomic sac of a Mollusc.

The long narrow tube which connects the cœlom and the nephridia is beset with small cæca, and, from about its middle point, gives off a long branched tube, which ramifies among the tissues of the base of the eyestalk and of the first antennæ. Similar tubules are given off from the bladder. All these cæcal appendages of the cœlomic system are lined throughout by an epithelium which is perfectly characteristic. The spaces found by Lankester in the limbs of *Astacus* are possibly derived from processes of the nephridio-cœlomic apparatus of the same nature as those in *Palæmon*. Mr. Weldon describes the structure of the nephridial apparatus, and points out that the comparison so often made between the glomerulus of the vertebrate kidney and the end-sac of the crustacean green-gland is abundantly justified, each glomerulus being the termination of a cæcal outgrowth from a bent nephridial tube, which communicates on the one hand with the body-cavity, and on the other, either directly or indirectly, with the exterior.

Phosphorescent Infection of Talitrus and other Crustacea.‡—M. A. Giard reports that he observed at Wimereux a *Talitrus* which was so phosphorescent that he could not accept the explanation of Quatrefages that it was due to the presence of *Noctilucæ* on the carapace. The animal was, further, observed to be moving slowly. Microscopical examination of an appendage showed that there were microbes in the muscles, the structure of which had been considerably altered. Treated with gentian-violet the microbe was seen to be a *Diplobacterium* 2 μ long. Specimens of the same genus and of *Orchestia littorea* were injected with these microbes, and the results surpassed the expectations of the author. Of ten *Talitri* inoculated on the 6th of September, six commenced to shine on the 8th, and on the 9th were as brilliant as the first specimen observed. The action of the microbe does not seem to become attenuated in successive generations, and is not modified by being inoculated into *Orchestia*. The light becomes so brilliant that two *Talitri* are quite sufficient to illuminate the face of a watch. After some days the creature dies, but its corpse remains phosphorescent for some hours; during the

* Journ. Marine Biol. Assoc., i. (1889) pp. 162–8 (3 pls). † *Ante*, p. 368.
‡ Comptes Rendus, cix. (1889) pp. 503–6.

course of the affection the power of the muscles becomes considerably affected. Such examples as did not become phosphorescent after being inoculated remained in perfect health. Other Crustacea, including the common Crab, have been rendered phosphorescent by the inoculation of this microbe.

Nervous System of Decapod Crustacea.*—M. L. Bouvier has studied the Decapod Crustacea in an ascending order, and, as a result, he comes to the conclusion that in a natural classification they would not be all placed in this order. The fresh-water Astacidæ, for example, appears to be a side branch of the marine Astacidæ; the Thalassinidæ appear to be marine Astacidæ which have sheltered themselves in the sand, and have ended by giving rise to the Paguridæ which take refuge in shells and form the third term of another branch. So, again, the Porcellanidæ, and perhaps the Anomura, are chiefly connected with the Galatheidæ, and serve as the point of departure for the true Brachyura. When the nervous system of the Macrura and Anomura is studied in these three branches, we see that the nervous system presents its maximum of condensation in the transverse direction in the "Salicoques" which are placed at the base of the suborder; in the Astacidæ this condensation is much diminished, especially in *Nephrops;* finally, in the Porcellanidæ and Galatheidæ, or the Paguridæ and Thalassinidæ, this transverse dissociation becomes more and more marked. In the Decapods, therefore, the concentration of the nervous system in the transverse direction diminishes as we approach the Brachyura.

This law is absolutely exact if the abdominal chain is considered; it is only relatively so if the thoracic ganglia are studied. But this difference can be easily explained. As the nervous system is dissociated transversely, it has a tendency to condense longitudinally. In the thoracic region, as compared with the abdominal, the ganglia are larger and more closely approximated, and the connectives which unite them are consequently shorter. And we may say, generally, that the condensation of the nervous centres and connectives in the longitudinal direction is inverse to that in the transverse direction; in the longitudinal it increases as we approach the Brachyura, and in the transverse it diminishes.

These statements are not true of other Crustacea or Arthropoda; the law is peculiar to the Decapoda, and may perhaps be of use in studying the affinities of the constituent members of the group.

In passing from the macruran to the brachyuran forms, an abdominal ganglion becomes part of the thoracic mass, the ganglionic chain shortens and is placed in the thorax, and this reduced chain enters into close contact with the centres of the thoracic region. The Galatheidæ and Paguridæ are at the first, the Porcellanidæ at the second, and the Crabs at the third stage.

"Liver" of Carcinus mænas.†—Dr. A. B. Griffiths describes a number of chemical investigations which seem to show that the so-called liver of the crab is pancreatic in function.

Genital Organs of Thelyphonus.‡—Herr J. Farnani has observed that the male sexual organs of *Thelyphonus asperatus* undergo remark-

* Ann. Sci. Nat., vii. (1889) pp. 78–106 (1 pl.).
† Proc. R. Soc. Edinb., xvi. (1888–9) pp. 178–81.
‡ Biol. Centralbl., ix. (1889) pp. 376–82.

able changes during sexual maturity. The female organs consist of two longitudinally folded saccular ovaries which extend throughout nearly the whole length of the abdomen, and have a rather large cavity; the dorsal side of the ovaries has no ovarian follicles; the second pair of ovaries described by Blanchard could not be found. The walls of the uterus are formed by a high glandular epithelium and a highly developed porous chitinized intima; at the sides are the openings of two receptacula seminis; near its hinder end the uterus forms two hollow, wing-like, highly chitinized outgrowths, which serve for the attachment of the muscles which are stretched vertically between the dorsal and ventral wall. The male organs of immature individuals consist of two tubular testes, which pass anteriorly into very narrow vasa deferentia; these open on the inner side of two reservoirs, which, again, are each connected by a short efferent duct with the anterior end of an unpaired cavity (uterus masculinus); this last opens into the genital cavity. This uterus has an unpaired blind sac on its upper wall and a seminal vesicle on each side; at its anterior end there is a circular chitinized pad. In sexually mature animals the genital cavity alters somewhat, numerous folds appearing in its walls. The epithelium of the uterus masculinus and its appendages becomes extraordinarily high, and the chitinous investment much thicker; on its lower wall a groove becomes distinctly noticeable, which extends from the opening of the blind sac to the hinder end of the uterus, where it diminishes remarkably in breadth. The reservoirs become much larger and fill up the anterior part of the abdomen, while the walls between them become absorbed and an unpaired reservoir is formed.

Transverse sections of sexually mature males reveal the presence of tubular glands with very characteristic contents on the dorsal surface of the whole abdomen; these glands open into the unpaired reservoir. The contents consist of small, rounded corpuscles with a central nucleus, of a homogeneous material which, in spirit-specimens, becomes converted into a yellow, hard, chitin-like mass, and of another homogeneous mass, which in spirit often breaks up into rounded corpuscles. This body is partly formed by the epithelial cells of the glands, which form two or three layers; the inner part of each cell breaks up into five or more pieces, and the final result is the formation of at least sixteen corpuscles, each of which contains a nucleus, and may therefore be regarded as a cell. Whether the other contents of the gland and of the reservoir are products of the further metamorphosis of these cells cannot yet be determined.

In conclusion, the author discusses, with figures, the homologies of the various parts of the generative apparatus in the two sexes.

Lucifer-like Decapod Larva.*—Mr. G. Brook took in the tow-net off the West Coast of Scotland a peculiar Decapod larva, which seems to be unlike any which has yet been described; in general appearance it is very like semi-adult forms of *Lucifer*, the development of which has been worked out by Brooks. It differs, however, in having five pairs of pereiopods, while *Lucifer* has only three in the adult and four in the embryo; the telson is triangular in form, as in the normal Zoea of Decapods; and the pereiopods and uropods are not developed till a relatively much later period than in *Lucifer*. As it has an elongated

* Proc. R. Soc. Edinb., xv. (1887-8) pp. 420-3.

neck, the author proposes to call it *Trachelifer;* as to its affinities, he is unable to speak definitely.

Life-history of Stenopus.*—Prof. W. K. Brooks reports on the investigation made by Prof. F. H. Herrick and himself on the young of this crustacean. The larvæ are very much larger than ordinary pelagic larvæ, and quite different from any known forms of Macrura. The chief locomotor organs are the fifth thoracic legs, which are extremely slender, as long as the entire body of the larvæ, and ending in flattened elliptical paddles, which are used as "sweeps" for rowing through the water. *Stenopus hispidus* has a cosmopolitan range, and in structure, habits, colour, and external appearance is one of the most highly specialized of Crustacea; its antennæ are long and slender, and the acuteness of its senses, together with its very remarkable alertness, the quickness with which it perceives danger and the rapidity with which it escapes, have undoubtedly aided it in holding its own whenever it has gained a footing in a suitable locality. The upper surface of its body and limbs is covered by a thorny armour of hooked spines, and as these all point forwards, the attempt to swallow a *Stenopus* must be difficult and painful. The length of its pelagic life is unquestionably an aid to its wide dispersal and to the discovery of new homes.

The eggs, which are very small, are laid at night, and during segmentation the yolk remains undivided. At the time of its escape the larva is a Protozoea, and its later history is of great interest, as it unites features of resemblance to *Lucifer*, *Sergestes*, *Peneus*, and to the prawns in general. At the time of hatching it has sessile eyes, locomotor antennæ, an enormous mandible, a deeply forked pleon, a long rostrum, and a complete series of appendages as far as the first pereiopods; the long hind-body has no appendage, and is only vaguely divided into somites. Five or six hours after hatching it changes into a true Zoea, much like that of an ordinary Macrouran.

In the Mastigopus-stage the eyes are greatly elongated, and the third maxillipeds are extremely long, while the huge oar-like fifth pereiopod of the preceding stage is reduced to a bud, and the fourth is also reduced and has only two joints. As in the Sergestidæ, therefore, the last two pairs of "walking legs" are shed after the Mysis-stage, to be again reconstructed in the Mastigopus-stage. After several months this last larval stage gradually assumes the adult form, the principal changes being the shortening of the eyes and the reacquisition of the fourth and fifth pereiopods.

Metamorphosis of British Euphausiidæ.†—Messrs. G. Brook and W. E. Hoyle give an abstract of their observations on the metamorphosis of British Euphausiidæ; the two most frequent forms are probably *Nyctiphanes* and *Boreophausia.* They give for the first time an account of one almost complete series of moults for one species. In their metamorphosis the Euphausiidæ stand almost alone, none of the later larval stages being identical with the Zoea and other larvæ of Decapods. They commence their life in the Nauplius condition, a type of larva frequent in other groups. The larval formation of the antennæ is retained until the commencement of the Cyrtopia-stage, a feature which is not usual among the Crustacea. The Calyptopis-stage, in which the compound

* Circ. John Hopkins Univ., viii. (1889) pp. 29–30.
† Proc. R. Soc. Edinb., xv. (1887–8) pp. 414–20.

eyes, while undergoing development, are covered by an anterior expansion of the carapace, is a remarkable one, which, so far as the authors know, is only met with in one other group—an aberrant section of the Decapoda, inclusive of *Lucifer* and others, where this condition obtains in the Protozoea-stage.

Male of Phronima sedentaria.*—Prof. C. Chun has a note on the male of *Phronima sedentaria* and observations on other species of the genus. Till quite recently this male had not been detected; it is very probable that it makes no special house for itself, as does the female. When they are sexually mature they develope the lower pair of antennæ; at the same time remarkable changes obtain in the appendages of other segments; the first joint of the flagellum of the anterior antennæ becomes enormous, and gets a thick covering of hairs. The tibia and metacarpus of the fifth thoracic appendage become wider, and on the metacarpus, with its complexes of glands, of the oldest males three teeth become apparent. By these and other changes in form the male of *P. sedentaria* becomes very much like that of *P. diogenes*, as described by Claus, though there are, it is true, several points of distinction. The changes, often rapidly effected, in the appearance of Phronimids should make us very careful of forming new species, and the author comes to the conclusion that *P. atlantica* Guérin-Méneville and *P. pacifica* Streets are young stages of *P. sedentaria*, while *P. novæ-zealandiæ* Powell and *P. borneensis* Sp. Bate are adult stages of the same widely distributed species.

Pelagic Copepoda of Plymouth.†—Mr. G. C. Bourne has investigated the Copepod fauna of the sea near Plymouth. He has been led to this owing to the important part played by these minute Crustacea in the change of material in the sea. Sixteen species were taken in the tow-net, nine of which belong to the family Calanidæ. *Oncæa mediterranea* is here for the first time recorded north of the Mediterranean.

Female Generative Organs and Oogenesis in Parasitic Copepoda.‡—Dr. J. H. List has investigated the history of the female organs in the Gastrodelphyidæ, parasitic Copepoda intermediate between the Notodelphyidæ and the Siphonostomata. The ovaries and oviducts are paired, there is a receptaculum seminis, and two canals with external orifices. The formation of the egg-cells is effected in the Gastrodelphyidæ in the ovary which is filled with polygonal cells. When formed the eggs are cut off in rows and pass into the oviduct where they receive the yolk-masses. The eggs which are given off are replaced by others formed in the anterior part of the ovary. The hinder part of the gonad forms a kind of latent germinal layer, the function of which is to provide cells for the anterior part. The ripe eggs, when set free, must pass the receptaculum seminis to reach the maternal cavity, and they are fertilized in it. In conclusion the author makes some observations on the similar parts in the Notodelphyidæ.

Vermes.

Agamic Multiplication of Lower Metazoa §—M. Maupas, who has shown that, by methodical cultivations of ciliated Infusoria indefinitely

* Zool. Anzeig., xii. (1889) pp. 378-82.
† Journ. Marine Biol. Assoc., i. (1889) pp. 144-52 (2 pls.).
‡ Biol. Centralbl., ix. (1889) pp. 327-33.
§ Comptes Rendus, cix. (1889) pp. 270-2.

prolonged, it is possible to produce senile degeneration, has made experiments of a similar kind with some of the Metazoa which multiply parthenogenetically and by budding. He has succeeded with some species of Rotifers and oligochætous Annelids. *Cyclogæna lupus*, a carnivorous Rotifer, was nourished on *Rotifer vulgaris*, and was kept at a temperature of 19–20° C. The ova were incubated in fifty-two or three hours, and the young took sixty-five to seventy hours to mature their first ovum. The maximum number of ovipositions was three a day. A herbivorous species of *Notommata* was followed through twenty-two uninterrupted generations from February the 6th to May the 18th; the length of incubation of the ova was from forty-seven to forty-eight hours at 15° C. and thirty-five at 19° C. *Callidina vaga* was followed through twenty-nine generations. Of Oligochæta, *Nais elinguis* and *Pristina* sp. were followed through a few generations only, but *Chætogaster diastrophus* through an uninterrupted series of forty-five generations. In no one of these cases was sexual generation observed. The author is not, at present, able to continue these investigations.

α. Annelida.

Polyodontes maxillosus.*—M. R. Saint-Loup has discovered near Marseilles the large Aphroditid which is called *Polyodontes maxillosus*. It is two metres long, and the diameter of the body near the head 20 mm.; further back it is only slightly attenuated. Various errors in Claparède's figure of the external characters are pointed out. The proboscis, when extruded, is rather wider than the body; it has, in front, four denticulated jaws, and the longest denticle is 4 mm. The cephalic lobe carries the eyes at the end of two stalks, which are fused along their line of contact; the projection of these organs is such that the worm can see in front of it, even when the proboscis is protruded. The delicate fringes which ornament the extremity of the proboscis are provided with ultramarine, phosphorescent granulations, which probably serve as a lantern at night.

Notes on Oligochæta.†—Mr. F. E. Beddard states that in the sexual form of *Dero* there are invariably two setæ only in each of the ventral bundles of the fifth segment; this worm appears to differ from other Naidomorpha by the entire absence of ventral setæ from the sixth segment; there is a single unpaired sperm-sac and egg-sac. In a new large species of *Perichæta* from Borneo the spermatheca showed a marked asymmetry. Some remarks are made on Dr. Rosa's recent criticism of some of Mr. Beddard's descriptions and systematic views.

Oligochætous Fauna of New Zealand.‡—Mr. F. E. Beddard points out that, though all the species from New Zealand described by Dr. Hutton are referred to the genera *Lumbricus* and *Megascolex*, most belong to other genera and especially to *Acanthodrilus*. Fourteen species, several of which are new, are enumerated in the present paper. *Rhododrilus* is a new genus which comes nearest to *Cryptodrilus* and *Megascolides*; its atria are tubular, penial setæ are present, and the clitellum occupies segments xiv.–xvii. It would appear that the oligochætous fauna of New Zealand differs markedly from that of Australia;

* Comptes Rendus, cix. (1889) pp. 412–4.
† Zool. Anzeig., xii. (1889) pp. 533–6.
‡ Proc. Zool. Soc. Lond., 1889, pp. 377–82.

the characteristic form is evidently *Acanthodrilus; Rhododrilus* and *Neodrilus* may be peculiar genera, and *Deinodrilus* has not been met with elsewhere. The fauna of New Zealand presents a marked agreement with that of Kerguelen, Marion Island, Patagonia, the Falkland Islands, and South Georgia; so that with regard to the terrestrial Oligochæta it seems permissible to speak of an "antarctic fauna."

Anatomy and Histology of Phreoryctes.*—An abstract has been published of Mr. F. E. Beddard's memoir on this Oligochæte. Among the new points discovered by the author are the absence of genital and penial setæ; the clitellum occupies three to four segments, from the tenth to the thirteenth; its epidermis is formed by a single layer of cells, differing from those of the epidermis generally by their greater length and glandular character. The nephridia of the sexually mature worm commence in the sixteenth segment. In both vasa deferentia and oviducts the distal section is lined with a chitinous membrane, which is continuous with that covering the body; they are in other respects closely similar, and the position of the external orifice of the second pair of vasa deferentia is intermediate between that of the first pair of vasa deferentia and of the oviducts. The ova, which are, when fully mature, of large size (one-half the diameter of the body), and loaded with yolk-granules, undergo their development in egg-sacs which are contained in the fourteenth to the sixteenth segments. The ova and egg-sacs are more like those of the Tubificidæ than those of earthworms. The author agrees with Vejdovsky in regarding *Phreoryctes* as the type of a distinct family; this must be placed between the earthworm and the lower Oligochæta.

Polar Body Formation in Aulastomum.†—Herr G. Platner describes the formation of the first polar body in *Aulastomum gulo*, with special reference to the so-called achromatin substances. The centrosoma, which he regards as a constant characteristic of the cell, is recognizable as a definite body, but in the ripe ovum it is quite naked without distinct ensheathing archoplasma. The polar body extrusion is introduced by the division of the centrosoma, round the products of which the yolk spherules become radially disposed. Soon, however, two typical archoplasmic spheres are established round the two daughter centrosomata. Contrary to Boveri's opinion that the ripe ovum was without centrosoma, Platner maintains that spermatozoon and ovum are, as regards nucleus and division centres, exactly equivalent at the time of formation of the first segmentation spindle.

β. Nemathelminthes.

Ovary and Oogenesis of Gordius.‡—M. A. Villot describes the long ovarian tubes of the female *Gordius* as consisting of a very delicate outer layer of the nature of connective tissue, and a much thicker inner layer formed of epithelial cells. The ova are not developed in the cavity of the ovarian tubes, but in lateral diverticula which are an essential part of them, and which are formed by exogenous budding of their wall. The contained ova are nothing but isolated and modified epithelial cells. The ova do not pass into the cavity of the ovarian

* Proc. R. Soc. Edinb., xvi (1888–9) pp. 117–9.
† Arch. Mikr. Anat., xxxiii. (1889) pp. 204–16 (1 pl.).
‡ Comptes Rendus, cix. (1889) pp. 411–2.

tube until they are mature, and this passage is the natural consequence of their development, increase in size, reciprocal pressure, and the elasticity of the wall of the ovigerous diverticula.

The fatty degeneration of the embryonic cells of the parenchyma which furnish the necessary food for the generative products is much more extensive in the female than in the male. In addition to the circumintestinal cavity, a cavity appears in the dorsal middle line; the complete degeneration at the time when the ova are deposited is very marked. The parenchyma does not become regenerated, and does not, as Vejdovsky supposes, form fresh gonads. *Gordius* reproduces only once in its life, and the females, shattered by oogenesis, die soon after they have deposited their eggs.

Life-history of a Free Nematode.*—M. R. Moniez has made a study of the metamorphosis and migration of *Rhabditis oxyuris*. After the young have acquired a certain size, they fix themselves to various Acari, and particularly to *Holostaspis marginatus*, in considerable numbers; sometimes, indeed, there are as many as sixty worms on one Acarid. The young *Rhabditis* secretes a large chitinous plate, to which it is suspended by a short pedicel; the tissues and organs are detached from the skin, which becomes altered in character, though remaining perfectly transparent; its elements fuse, and the refractive granules which mark the rudiments of the reproductive organs disappear. There is thus formed an ovoid body which is much smaller than the larvæ at the expense of which it was formed, is completely detached from its old skin, and has the digestive tube in the form of a narrow longitudinal cleft.

From the commencement of metamorphosis a long tail begins to appear; in time the new larval form breaks away from the old one. The author has not yet been able to trace the further history of the second larva.

Filaria medinensis in Animals.†—Prof. A. Raillet points out that, although *Filaria medinensis* is generally considered a human parasite it is found in other Mammals, such as the Dog, Horse, Cow, and Jackal. Though the pathological conditions which it determines are much the same, it does not produce the painful complications seen in Man.

Pseudalius alatus.‡—Dr. O. v. Linstow gives a description of the form which, in 1848, Leuckart called *Strongylus alatus*; the new account differs considerably from the original, which was drawn up when our methods of research were less perfect. The author remarks that the six known species of the genus appear to flourish where there is an abundant supply of oxygen, since they live in air-containing organs or in the blood-vascular system; thus *P. alatus* is found in the pharyngeal cavities, mouth, and Eustachian tube of *Monodon monoceros*; four species are found in the air-cavities and blood-vessels of the Porpoise, and *P. ovis pulmonalis* in the bronchi of sheep.

Spiroptera alata, a new Nematode found in Rhea americana.§—Dr. F. Zschokke found in the crop of a *Rhea americana* a male specimen of *Spiroptera*. Apart from the size, it is distinguished from *S. uncipenis*,

* Comptes Rendus, cix. (1889) pp. 506–7.
† Bull. Soc. Zool. France, xiv. (1889) pp. 73–6.
‡ Proc. R. Soc. Edinb., xvi. (1888–9) pp. 15–7 (1 pl.).
§ Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 792–4.

which was found by Molin in the same host, by the presence of wing-like appendages which project from the head. There are also minor differences both at the anterior and posterior ends. The animal is about 30 mm. long and about 1 mm. broad, and a minute description is given of it.

Vitality of Trichinæ.*—M. P. Gibier finds that if small fragments of trichinized flesh be exposed to a temperature of 20 or 25 degrees below zero, they exhibit a characteristic activity such as is not seen in trichinæ of salted meat before refrigeration.

γ. Platyhelminthes.

Fresh-water Turbellaria.†—Dr. E. Sekera first discusses the sexual relations of *Microstoma;* sexual and asexual reproduction may be seen in the same individual, and at the same time. The gonads are found both in separate individuals and in the zooids, and are generally of one sex only; in rare cases, however, hermaphroditism obtains, and this is a condition which the author is inclined to regard as atavistic; in such cases the male gonads are developed before the female.

The genus *Stenostoma* should be removed from Graff's family of the Microstomidæ, and form an independent group of Stenostomidæ, in which should also be placed the genera *Catenula* and *Rhynchoscolex.* In the third part of his work the author gives an account of some new or little known species—these are *Mesostoma hirudo* Schmidt, *Vortex coronarius* Schmidt, *V. paucispinosus* and *Bothrioplana alacris* spp. nn.

Microstoma papillosum.‡—Dr. L. Böhmig finds that in *Microstoma papillosum* the genital products are produced in two (sexual) individuals; that the colonies are monœcious, and that, in all probability, asexual reproduction ceases during sexual reproduction, and that chains, the individuals of which possess genital organs, consist of two individuals of the first order. Sections must be made to determine whether the separate individuals of the chain are unisexual or hermaphrodite.

Notes on Entozoa.§—Signor F. S. Monticelli has notes on some new and rare species in the collection of the British Museum. *Distomum microporum* is a new species found in *Plagyodus ferox;* Trematoda have not before been observed in the Plagyodontina. *Pelichnobothrium speciosum* sp. n., from *Alepidosaurus ferox,* is the type of a new genus in which the head has a large pyramidal haustellum, truncated anteriorly and provided with a well-developed terminal sucker; there are four bothria which have the form of a basin, and are completely adherent to the head; each has an accessory scrobiculiform sucker, and they are arranged in couples on either side of the head. *Tænia falciformis* Baird was, with a query, said to have an unarmed rostellum; Signor Monticelli finds that it is armed with eight very slender and long hooks of characteristic form. Similarly, *Tænia calva* Baird from the grouse (*Lagopus scoticus*) has not an unarmed rostellum, but one which is provided with a small crown of very numerous minute hooks. *T. bifaria,* enumerated

* Comptes Rendus, cix. (1889) pp. 533–4.
† SB. K. Böhm. Gesell. Wiss., 1888 (1889) pp. 304–48 (4 pls).
‡ Zool. Anzeig., xii. (1889) pp. 479–83.
§ Proc. Zool. Soc. Lond., 1889, pp. 321–4 (1 pl.).

in Baird's Catalogue as a species of Von Siebold's, does not appear to have ever been described; the author now gives an account of it.

Helminthological Notices.*—Dr. Sonsino has given an account of the entozoa of the Long-eared Fox (*Megalotis cerdo*) of Egypt. Among them are *Tænia echinorhynchoides* sp. n., on the rostellum of which there are twelve to sixteen transverse rows of hooks similar to those of *T. cucumerina; Echinorhynchus pachianthus*, which is much smaller than *E. gigas; Physaloptera cesticillata* and *Heterakis crassispiculum* spp. nn. A larval form of cestode found in the subcutaneous connective tissue of the Jackal (*Canis aureus*) is suspected to be the young of *Bothriocephalus Mansoni*.

Tristomum elongatum.†—Prof. M. Braun makes some additions and corrections to v. Baer's description of this Trematode. The excretory organs open by a large flask-shaped vesicle in the region of the pharynx; numerous fine anastomosing vessels may be easily seen in the anterior transparent parts of the body, but ciliated infundibula could not be detected. All the vessels are, on each side, collected into an anterior and posterior primary trunk, which open separately into the base of the excretory vesicle. In front of the pharynx the brain may easily be seen, as well as four thick nerve-trunks, which soon break up into anastomosing branches and supply the very mobile anterior part of the body; posteriorly there arise two thick trunks, which soon bifurcate and can be followed to the hinder end, where they pass into the sucker. There are two larger and two smaller black eyes on the brain. Numerous yolk-follicles are to be found among the enteric appendages; they pour their secretion into two anterior shorter, and two posterior and longer yolk-ducts; the latter unite and pass into the yolk-reservoir, which lies in front of the ovary; from this a canal takes a somewhat winding course to the uterus. In front of this last lies the cirrus, the nature of which was misunderstood by von Baer. No vagina could be found in the fresh animal, and the author doubts whether one is present. Further, histological, details are promised.

δ. Incertæ Sedis.

Anatomy of Dinophilus.‡—Mr. S. F. Harmer gives an account of the anatomy of *Dinophilus tæniatus*, a new species found at Plymouth. With regard to the affinities of the genus, the author agrees with previous observers, and especially Weldon, as to its archi-annelid relationships. He points out that the presence of two rings of cilia on each segment is common to the new species and to *Protodrilus leuckarti*. There is a close resemblance in the nervous systems of these two genera, save that that of *Dinophilus* (like that of *Histriobdella*, an undoubted archi-annelid) is segmented. The nephridia of *D. tæniatus* closely resemble those of *Protodrilus*, as described by Hatschek. In many of its features *Polygordius* differs from *Dinophilus* far more than does *Protodrilus*, but, on the other hand, *Histriobdella* is probably more closely related to *Dinophilus* than is *Protodrilus*. Although it seems so clearly an archi-annelid, we may agree that *Dinophilus* gives evidence of having been derived from Platyhelminth-like ancestors. In the per-

* Arch. Ital. Biol., xii. (1889) pp. 295-6.
† Zool. Anzeig., xii. (1889) pp. 433-4.
‡ Journ. Marine Biol. Assoc., i. (1889) pp. 119-43 (2 pls.).

sistence of the præ-oral ring of cilia, probably of the head-kidneys, as well as in the general characters of the enteric canal, the adult *Dinophilus* may be considered to remain in a condition which is practically that of a trochosphere.

Rotifera.*—Dr. C. T. Hudson has issued a supplement to the well-known work by himself and Mr. Gosse on the Rotifera. He gives in it a description of every known foreign species, as well as of such British ones as have been discovered since 1886. More than 150 species are here described, and more than 40 doubtful or imperfectly described forms are briefly discussed and occasionally illustrated.

Echinodermata.

Homologies within the Echinoderm-phylum.†—Dr. R. Semon compares the several organs of the representatives of different orders of the Echinodermata with one another. Some of them he regards as completely homologous—such are the enteric system, the enterocœl, the water-vascular, and the nervous systems. Other structures are merely analogous or homoplastic, as are, for example, many parts of the skeletal apparatus. Other structures are neither homologous nor analogous, for the common organ from which they were derived was of so indifferent a nature that from it there have been independently developed in the various classes organs which are sometimes similar and sometimes very different. Under this head may be placed the musculature; it is in all cases derived from the typical dermomuscular tube, but presents great differences in Holothurians, Starfishes, and Sea-urchins; here, too, come parts of the water-vascular apparatus and of the nervous system of Holothurians. If we suppose that the primary tentacles of Holothurians correspond to those of the other classes, the water-vessels of the body and the nerves of Holothurians have only a general and not a special homology with those of the other classes; if, on the other hand, we regard the secondary tentacles of Holothurians as strictly comparable to those of the other classes, then the primary tentacles have only a general homology.

In the present state of our knowledge it is impossible to decide how far the blood-vascular systems of the various classes are generally or specially homologous or merely homoplastic; the dorsal organ has probably a general homology.

Comparative anatomy indicates that the classes of the Echinodermata were certainly derived from a common stem-group, but this, in its general structure, exhibited somewhat indifferent characters, and the various classes have diverged in their development from this point of origin. The history of development appears to support this view. The author congratulates himself that the views he has already expressed have been confirmed by the investigations of the Drs. Sarasin.

The simplified *Synapta* of the Sarasins is not very different to the pentactula-like stem-form of the author; but they are not quite correct in speaking of this as a *Holothuria*-stage.

Neumayr is also inclined to recognize a very early divergence of the classes from simple stem-forms, but he regards the Echinoids and

* 'The Rotifera or Wheel Animalcules,' by C. T. Hudson, assisted by P. H. Gosse. Supplement, London, 1889, 64 pp., 4 pls.

† Morphol. Jahrb., xv. (1889) pp. 253–307.

Asterids as having been longer and more closely connected than, in the opinion of Dr. Semon, the facts warrant. It does not seem to be justifiable to identify the Cystids with these indifferent stem-forms. We know nothing of their internal organization, and what we do know of their skeleton does not support this view.

Embryology of Muelleria Agassizii.*—Mr. C. L. Edwards has investigated the development of this common Holothurian. The eggs are quite opaque, of a brownish colour, and surrounded by a structureless zona radiata. Three polar globules, one considerably larger than the other two, are extruded; the segmentation is total and nearly regular; a gastrula is formed on the beginning of the second day. The embryo becomes ciliated, and during the next day appears to pass through an abbreviated auricularia-stage. By the fifth day the embryo developes five oral tentacles and the beginning of the calcareous skeleton of the larva, while green pigment-spots also appear. On the fifth or sixth day the embryo, by means of its tentacles, breaks the tough investing coat and begins to creep about. On the sixth day an ambulacral foot arises at the posterior end and grows so rapidly that, on the eighth day, it exceeds the oral tentacles in length. On the eleventh day a second, and on the fourteenth a third ambulacral foot appears, and in such positions as to differentiate the ventral surface.

In the meantime the calcareous rods have been getting longer and branching; the branches anastomose to make rosette forms, while from the centre of each of these rosettes arise two vertical spines, which are at first free and are then joined to one another by cross-bars. The intestine is plainly visible as an orange-red body, and the anus is guarded by two valves, formed of fused calcareous rods, running longitudinally to the body, which wave, fan-like, from side to side with the cloacal respiratory movements. Quite early a circulation of granules and corpuscles may be noted in the ambulacral system.

By the thirtieth day a fourth ventral foot has become developed, and the budding fifth appears, while, near to the base of the oral tentacles, dorsally and laterally, there appear respectively the beginnings of a pair of ambulacral feet. By the forty-second day a fifth ventral foot has partially developed, and two additional pairs of lateral feet have budded from the middle and posterior portion of the sides.

In the first day after hatching the sucking discs of the oral tentacles have shown the beginning of division into two lobes; somewhat later these each divide into two lobes, giving the basis for the dichotomous division of the tentacles in the adult.

These Holothurians are not difficult to rear, and some were under observation for eighty-four days.

Boring Sea-Urchins.†—Herr G. John has an essay on the somewhat vexed question of the manner in which sea-urchins bore into rocks. He comes to the conclusion that the cavities which they inhabit have been formed by themselves, and that they produce them by means of their masticatory apparatus, which is aided to some extent by their spines, as the creatures move round and round. These cavities are formed as a protection against the action of the sea. The calcareous algæ which cover the rocks inhabited by the sea-urchins are deposited mechanically,

* Circ. John Hopkins Univ., viii. (1889) p. 37.
† Arch. f. Naturgesch., lv. (1889) pp. 268–302 (1 pl.).

and have no influence on the chemical character of the surface of the rocks, and they cannot therefore be supposed to have any connection with the origin of the *Echinus* holes.

Saccular Diverticula of Asteroidea.* — Dr. A. B. Griffiths and Mr. A. Johnstone find that the saccular diverticula are pancreatic in function; the same tests were applied as to *Tegenaria*.†

New Ophiurids.‡—Mr. J. E. Ives describes a new genus of Ophiurids, which he calls *Ophioncus* (*O. granulosus* sp. n.); it is the only genus, except *Ophiura*, that has the genital slit divided; but it differs in having the inner opening larger and not smaller than the outer one. In general characters and in structure of its arm-bones the new genus seems to be nearest to *Ophiozona*.

Cœlenterata.

Chun's Cœlenterata.§—Prof. C. Chun has commenced a new edition of such of Bronn's Klassen u. Ordnungen as dealt with the Cœlenterata. The first part deals only with the history of the group.

Occasional Presence of a Mouth and Anus in Actinozoa.‖ —Mr. H. V. Wilson calls attention to the occasional occurrence of actinians or corals in which there are permanently separate openings into the gastric chamber. If the theories of Sedgwick and E. B. Wilson are correct, this is precisely the variation which must have occurred in the ancestral radiate, and to which bilateral animals owe their existence. Among many examples of the large actinian which is called *Cereactis bahamensis*, one had the free lips of the œsophagus grown together along the sagittal axis, except where the sagittal furrows opened into the gastric chamber. Here there were two small circular openings. The concrescence was an actual and perfect union of tissue, and the animal was an adult of normal size, and thoroughly healthy. The union of the lips must, however, have affected its feeding, for it must have made it impossible for the creature to eat small gastropods, such as are often found in the gastric chamber of these anemones. A similar variation was observed in a single swimming larva of the coral *Manicina areolata*.

Arrangement of Tentacles in Cerianthus.¶ —Dr. P. Fischer points out that the view that the tentacles of *Cerianthus membranaceus* vary in number, but are always paired, is incorrect, for there is always an odd number of them; this is due to the presence of an unpaired tentacle, which is constantly found near one of the angles of the mouth, and serves to determine the ventral side of the animal. He finds that the marginal tentacles of the first cycle correspond to the buccal tentacles of the second; that the marginal tentacles of the second correspond to the buccal tentacles of the third, and that the marginal tentacles of the third cycle correspond alternately to the buccal tentacles of the first and third cycles.

The bilateral symmetry of *Cerianthus* is demonstrated by the arrangement of the buccal tentacles, while, on the contrary, the marginal tentacles generally indicate a radial symmetry. On the other hand, the

* Proc. R. Soc. Edinb., xv. (1887–8) pp. 114–5. † See *ante*, p. 746.
‡ Proc. Acad. Nat. Sci. Philad., 1889, pp. 143–6.
§ Bronn's Klassen u. Ordnungen, ii., 2, Cœlenterata (1889), pp. 1–48.
‖ Circ. John Hopkins Univ., viii. (1889) pp. 37–8.
¶ Bull. Soc. Zool. France, xiv. (1889) pp. 24–7.

existence of an unpaired ventral tentacle, either marginal or dorsal, the form of the mouth, the arrangement of the mesenteric septa, and the prolongation of two of these septa as far as the pedal pore, together with the mode of development of the embryo, furnish an accumulation of proof in favour of that bilateral symmetry of *Cerianthus* which has already been urged by Haime.

Madrepore Corals from Ceylon.*—Dr. A. Ortmann describes the collection of madrepore corals, brought by Prof. Haeckel from Ceylon, and has been led to some new conclusions in regard to the systematic relations and morphology of these Anthozoa. Of Athecalia, ten new species are described; of Pseudothecalia, two; of Euthecalia, one; while a great number of forms, previously recorded, are briefly diagnosed. As will be seen from these names, the investigator follows Heider's division of the Madreporaria, and distinguishes the three orders as follows:—

	Athecalia.	Pseudothecalia.	Euthecalia.
Theca	0	0	compact.
Synapticula	present, sometimes forming a cœnenchyma or a porous wall.	meeting in a false wall, otherwise absent.	0
Cœnenchyma	from united synapticula, or absent.	from costal-cœnenchyma, or absent.	absent, or compact and not distinguishable from the wall, or forming a vesicular exotheca.
Septa	those of adjacent calices coalesce, or lose themselves in the cœnenchyma or porous wall, trabecular, porous or compact, toothed.	those of adjacent calices meet, or are prolonged as keeled ribs over the false wall, trabecular, compact, rarely somewhat porous above, toothed.	not coalescing, not (?) trabecular, compact, margin entire.
Traversals, Floors or Dissepiments	present or absent.	usually numerous.	present or absent.
Extra material	0	0	sometimes a solid mass of lime in the calyx.

The Athecalia are then divided into Thamnastræacea, Madreporacea, and Fungiacea; the Pseudothecalia include especially the Astræinæ and

* Zool. Jahrb., iv. (1889) pp. 493–590 (8 pls.).

Echinoporinæ, most of Duncan's Astræidæ, and all the Lithophylliaceæ; while the Euthecalia comprise apparently all the genera of Oculinidæ, many if not all Turbinolidæ, Eusmilinæ, and Euphylloidæ.

After a chapter on the nomenclature of coral structures, Dr. Ortmann proceeds to discuss the formation of the coral stock or colony, with special reference to *Fungia*, which he regards "as a true stock with division of labour such that in the centre there is situated a large, radiate person with an oral aperture, and round about this numerous smaller individuals, of each of which only a tentacle persists."

A discussion of the radiate symmetry and the development of septa leads on to the question of the Tetracoralla, in regard to which Ortmann urges (1) that there is no essential difference between them and Hexacoralla, (2) that bilateral corals are predominantly solitary forms, (3) that since Palæozoic times the bilateral type has been on the wane, and that in the development of the Hexacoralla the bilateralness is pushed back to a very early embryonic stage, (4) that the Hexacoralla have sprung directly from Tetracoralla.

Milne-Edwards' law of the increase of the septa is modified into the following:—In 6-radiate corals, the number of septa grows in such a way that new septa arise throughout where there is room for them. If a coral has a more or less regular shape, then the new septa conform, but always in the closest connection with the external form of the coral, and directly explicable in relation to the same.

The author thinks that twelve (certainly not six) is the fundamental number for Hexacoralla, and finally sums up with a few modifications his previously published conclusions on the general pedigree of the Hexacoralla.

Bunodes and Tealia.*—Messrs. G. Y. Dixon and A. F. Dixon have some notes on *Bunodes thallia*, *B. verrucosa*, and *Tealia crassicornis*. The first of these resembles *Tealia bunodiformis* in the possession of "endodermal saccules," the form and arrangement of the mesenteries, and the nature of the circular muscles. In order to ascertain the generic and specific value of these characters the other two species were investigated, and the conclusion was arrived at that if *B. thallia* and *T. bunodiformis* are not identical, they are at least more closely allied to each other than to either of the two other forms with which they have been compared. According to the present systematic arrangement of Hertwig, an adult *Tealia crassiformis* with its parts in multiples of five, an adult *Bunodes verrucosa* with its parts in multiples of six, and an adult *B. thallia* with no apparent numerical symmetry, are all relegated to the same family.

Edwardsia-Stage in Free-swimming Embryos of a Hexactinian.†—Mr. J. P. McMurrich, in studying some swimming embryos of *Aulactinia stelloides*, found that they passed through a stage with eight mesenteries, the longitudinal muscles of which were arranged as in *Edwardsia*. The hexactinian arrangement is derived from this by the formation of the fifth and sixth pairs of mesenteries, which make their appearance respectively between the dorso-ventro-lateral and the ventro-lateral and ventral directive mesenteries.

* Scient. Proc. R. Dublin Soc., vi. (1889) pp. 310-26 (2 pls.).
† Circ. John Hopkins Univ., viii. (1889) p. 31.

New Type of Dimorphism found in Antipatharia.*—Mr. G. Brook reports that a study of the 'Challenger' collection of Antipatharia has shown that some of the genera are dimorphic, while others are not. In *Antipathes* the zooids are of the normal sextentaculate type, but show a tendency to become elongated in the transverse axis; in *Parantipathes* the transverse mesenteries become enormously elongated, so that the length in the transverse axis is three or four times that in the sagittal; this elongation has the effect of carrying the "lateral" tentacles further away from the stomodæum, so that they now appear as three pairs some distance apart; in *P. larix* the peristome becomes somewhat depressed on each side of the oral prominence, so that the zooid presents indications of a division into three lobes: one central, containing the stomodæum and the proximal ends of all the mesenteries, and two lateral, which contain the greater part of the transverse mesenteries; it must be remembered that the reproductive elements are borne on the transverse mesenteries only, and in *Parantipathes* they are confined to such portions as are situated within the lateral lobes. In *Schizopathes* the three lobes of the zooid become separated from each other by a further depression in the peristome and by the formation of a mesoglœal septum; each lobe of the primitively simple zooid thus becomes separated from its neighbour, and in *Schizopathes* may be considered as dimorphic forms. The middle one, which contains the stomodæum, may be called the gastrozooid, while the lateral, which contain the two reproductive organs, may be distinguished as gonozooids. In *Bathypathes* the differentiation is carried a step further, for the individual zooids are separated from one another by considerable intervals, though still connected together by axial prolongat ons of their cœlentera.

The author proposes to divide the Antipathidæ into the two subfamilies of the Antipathinæ and the Schizopathinæ; *Parantipathes*, which is placed in the former, being the link between them. This is the first observed case of dimorphism of this kind in the Zoantharia generally, and is, further, of interest, as being brought about by the division of one zooid into three, and not by a specialization of different individuals; it differs, therefore, essentially from the dimorphism of *Madrepora Durvillei*, or that of Hydroids.

Organization and Phylogeny of Siphonophora.†—Prof. C. Claus has a somewhat severe review of "E. Haeckel's so-called Medusome-theory."‡ He points out that eleven years ago he showed that the Medusa-theory and the Hydroid-theory are not as irreconcilably opposed to one another as Haeckel asserts; this statement is supported by various quotations. It is urged that the Medusome-theory is a new variety of the Medusa-theory, but it loses probability in the same degree that Haeckel's new special assumption appears arbitrary and unfounded. The proposed new classification, the basis of which is the assumption of a special stem-form for the Discoideæ, which may be easily and naturally derived from the Physophoridæ, will have to be rejected as a novelty by no means justified by the state of the case. Prof. Claus raises similar objections to the many new names proposed and to the new nomenclature for the parts and appendages of the Siphonophora. He thinks that the

* Proc. R. Soc. Edinb., xv. (1888-9) pp. 78-83.
† Ann. and Mag. Nat. Hist., iv. (1889) pp. 185-98.
‡ This Journal, 1888, p. 741.

special descriptive part of Haeckel's work is much more valuable than the general, though too many genera have been proposed, and that there was no need to make a special order for the remarkable deep-sea genera *Stephalia*, *Auralia*, and *Rhodalia*.

Porifera.

Monograph of Horny Sponges.*—Dr. R. v. Lendenfeld has published a monograph of the Horny Sponges; there are 1641 (not always correct) bibliographical references. In investigating sponges it is recommended that for the study of the canal system longitudinal sections perpendicular to the surface should be made, as they give a much clearer insight into the structure than any others; some of the sections should be as much as 0·3 mm. thick, as particularly thin sections are generally useless for the purpose of studying the canal system. It is important to prepare portions of the skin, and the skeleton should always be studied both dry and wet. Skeletons macerated in the sea and thrown up on the beach are, as a rule, superior for the purpose of studying the rough anatomy of the skeleton to those artificially prepared. In the general accounts of the genera the author ordinarily gives a historical introduction, and accounts of shape and size, colour, surface, rigidity, canal-system, skeleton, histology and physiology, affinities of the genus, statistics of the species, key to the species and varieties, and distribution.

The author does not consider that the Horny Sponges form a natural order, but that different groups of them are structurally allied more closely to other groups of not horny sponges than to each other. An artificial group, of new extent, that of the Monoceratina, is formed for the Aulenidæ, Spongidæ, and Spongelidæ, each of which represents a natural group allied to a family of siliceous Cornacuspongiæ.

In the synthetical portion of his work the author discusses the morphology, histology, and physiology of Sponges, their embryology, and the homology of the embryonic layers; he also enters into the question of the phylogeny of the Sponges in general, discusses their systematic position, and gives a system of Sponges.

The plates give photographic illustrations of the general appearance of various Horny Sponges, and figures of preparations of chiefly the skeleton and the canal-systems.

Metamorphosis of Larva of Spongilla.†—Herr O. Maas has investigated the development of *Spongilla*. He describes the young larvæ as swimming about by the active movement of their flagella, and as seeking the darker parts of the aquarium in which they were being studied. In form they are distinctly ovate; the ectoderm consists of high cylindrical cells with elongated nuclei; the interior of the larva is too dense to allow of much being made out. The larvæ become fixed at the anterior pole, and their contour becomes much changed owing to the enlargement of the surface; at the same time the whole ectoderm becomes flattened, and in time the boundaries between the cells disappear. This flattening of the ectoderm results in great changes in the form of the cilia, which, at first closely packed, become in time widely separated. After this a peculiar change occurs in the ectoderm; its sharp wavy boundaries appear to be broken at various points; this is due to the ectoderm at

* London, for the Royal Society, 4to, 936 pp., 50 pls., 1889.
† Zool. Anzeig., xii. (1889) pp. 483–7.

the apparently broken points becoming converted into an extremely thin hyaline layer, which sends out pseudopodia-like processes. As a result of all its changes, the ectoderm of the larva of *Spongilla* becomes completely converted into the epithelium of the young Sponge.

Sections through young oviform larvæ show that the so-called endodermal nucleus is not an indifferent mass of tissues, but contains more or less perfect flagellate chambers, as well as spicules and other mesodermal elements. The spindle-shaped cells which Goette describes as lying immediately beneath the ectoderm were also found by Herr Maas to be always separated from it by a layer of mesodermal cells. Sections made after the larva has become fixed show this relation of parts very distinctly.

Protozoa.

Bütschli's Protozoa.*—Prof. O. Bütschli has brought to completion the work on which he has been engaged for the last ten years. In the presence of this great undertaking, so successfully completed, we may be allowed to depart a little from the reserve which characterizes the abstracts in this journal and offer him, in the name of general biological as well as specially microscopical students, our congratulations and thanks for this monumental work.

The pages which remain to be reported on treat of the Suctoria, which are fully dealt with; to these there are appended a short notice of Haeckel's system of the Radiolaria published in 1887, a very interesting postscript relating to the history of the work, a systematic index of names extending over sixty columns, an index of authors, a useful note as to the pages at which some general questions are discussed, and a few corrections and additions.

Psychology of Protozoa.†—Dr. G. J. Romanes reviews the two works whose titles are cited below; ‡ of the first he declares that but for the title-page he would have doubted the authorship of the work. The second is "charged throughout with the experimental work of a physiologist, and with the analytical powers of a well-instructed mind." There does not seem to be any evidence at all of even the lowest degree of mental life in any unicellular organisms. The Protozoa afford an exception to the general rule that in excitable tissues the principal seat of excitation is the kathode on closing and the anode on opening a galvanic circuit. When a galvanic current is closed through a drop of water containing a number of Protozoa, they will all begin to travel rapidly and directly to the negative pole, and, if the current be left closed for a few seconds, will all become congregated thereat. On now opening the current they will all begin to travel towards the positive pole, but then soon segregate. By using a movable kathode of harmless material the Protozoa may be led about like a flock of sheep following their shepherd. No evidence, but rather the contrary, was collected as to the value of the nucleus as a co-ordinating centre of movements, ciliary or otherwise, for unnucleated portions continue to exhibit all the same spontaneous movements as the nucleated.

* Bronn's Klassen u. Ordnungen, i., Protozoa (1889) pp. 1841–2035 (pls. lxxvi.–ix.).

† Nature, xl. (1889) pp. 541–2.

‡ A. Binet, 'The Psychic Life of Micro-organisms.' Translated from the French (Chicago, 1889). Dr. Max Verworn, 'Psycho-physiologische Protisten-Studien: experimentelle Untersuchungen' (Jena, 1889).

Method of Demonstrating Presence of Uric Acid in Contractile Vacuoles of lower Organisms.*—Dr. A. B. Griffiths has been able, by direct experiment, to show that at certain times the contractile vacuole of the Protozoa performs the function of a true kidney. A number of *Amœbæ* were placed on a microscopic slide and covered by a thin glass slip; alcohol was run in to kill them, and was followed by nitric acid. The slide was gently warmed and ammonia introduced. In a few minutes prismatic crystals of murexide, having a beautiful reddish-purple colour, made their appearance. Similar results were obtained with *Vorticella* and *Paramæcium.*

Symbiosis of Algæ and Animals.†—Prof. A. Famintzin states that the Alga with which *Tintinnus inquilinus* is symbiotic, is not, as previously supposed, an *Ectocarpus*, but a diatom belonging to the genus *Chætoceros.* It unites itself with a 1–5-celled colony of the diatom, its envelope becoming completely welded with it. When the union takes place at an early stage, the horns of the diatom frequently fail to develope.

The yellow cells of the Radiolaria are identified by the author with *Zooxanthella extracapsularis* and *intracapsularis*, the former only of which is known to develope outside the host. In opposition to the statement of Brandt, the author finds that the Radiolaria, especially *Collozoum inerme* and *Sphærozoum punctatum*, live on the yellow cells not only immediately before the formation of the spores, but at all times, imparting to them their golden yellow or rusty brown colour; and the same is the case also with several Actiniæ.

Holotrichous Infusoria.‡—In the introduction to his description of some Holotrichous Infusoria, Dr. W. Schewiakoff defines certain terms which he uses. Very small forms are those which do not measure more than 0·04 mm.; small, those not more than 0·07 mm.; of medium size, those less than 0·12 mm.; the large are not more than 0·25 mm., and very large those that are more. But these definitions are, of course, conventional. Stiff Infusoria are those whose bodies undergo no alteration in form; elastic those which do not change of themselves but are altered in consequence of some external pressure, on the cessation of which they return to their former form. Flexible Infusoria have the power of independently altering without making any noticeable change in their general form; while contractile Infusoria are those which can lengthen or shorten one dimension at the expense of others, and are, consequently, able to alter their form very considerably; in such cases special contractile elements are generally present.

The ectoplasm of Infusoria has generally the appearance of a thin, sharply limited layer of protoplasm, which is distinguished from the rest by its greater density and its higher refractive power; it is either homogeneous or has the special alveolar structure first described by Bütschli. The name of pellicula is suggested in place of the ordinary term cuticula, as this bounding lamella is not a dead secretory product, but merely a metamorphosis-product of the protoplasm. Between the alveolar layer and the endoplasm a specially differentiated layer can, in some cases, be distinguished, and for this we may well use Bütschli's name of cortical

* Proc. R. Soc. Edinb., xvi. (1888–9) pp. 131–5.
† Mém. Acad. Imp. St. Pétersbourg, xxxvi. (1889) 36 pp. and 2 pls.
‡ Bibliotheca Zoolog., v. (1889) 78 pp. (7 pls.).

protoplasm. This is either homogeneous or alveolar in structure; in this layer trichocysts or trichocyst-like structures and pigments may be deposited. The author gives detailed accounts of twenty-five forms, among which are *Glaucoma macrostoma* sp. n., *Urozona Bütschlii* g. et sp. n., and *Balantiophorus minutus* g. et sp. n.

Pigment of Euglena sanguinea.*—M. A. G. Garcin has studied the colouring matter of this organism, regarded by Ehrenberg as a distinct species, by Stein and Kent as a form of *E. viridis*, with which latter view the author agrees. He gives its spectroscopic properties, and finds it to be composed of extremely fine granulations, insoluble in water or cold alcohol, soluble in chloroform and concentrated nitric acid, and turning blue under the action of sulphuric acid. This substance, to which the author gives the name *rufin*, is identical with Rostafinski's chlororufin, the colouring matter of *Hæmatococcus*, *Chlamydomonas*, *Trentepohlia*, the antherids of Characeæ, and the oospheres of *Bulbochæte*. It is not, however, identical with Liebermann's chrysoquinone, nor with the colouring matter of the pigment-spot (eye-spot) of the lower algæ, which is not turned blue by sulphuric acid.

New Proteromonas.†—M. J. Kunstler gives a description of a new *Proteromonas* which was found living commensally with the Green Lizard in Gascony. The filiform body is about 15 μ long. The body is more or less of an S-shape, and is at the same time twisted on itself. The hinder extremity terminates in a fine point which may be of some length. At the anterior end there is a single long flagellum the base of which varies somewhat in character. This flagellum may be two to five times the length of the body, is of some thickness, and often undulating or spiral in shape. The author proposes to call it *P. dolichomastix*. It is somewhat smaller than *P. Regnardi*.

Podophrya from Calcutta.‡—Mr. W. J. Simmons gives a short account of a species of *Podophrya* from Calcutta. The body is from 1/800 to 3/4000 in. in length, is about 1/1000 in. broad, and the stem is about 1/1500 to 1/2000 in. in length. The form of the body appears to vary somewhat. The colour is whitish, and in only one case were the tentacles observed to present a knobbed appearance.

Structure of Rhizopod Shells.§—Herr F. Dreyer, after explaining the most important points in the structure of the shells of the Rhizopoda, attempts to give some explanation of the phenomena. The chief cause of the form-types of the soft body and of the shell is to be sought for in the mode of life of the Rhizopoda. Those that have shells belonging to the perforate type and with pseudopodia radiating uniformly on all sides, live free and rotating in the water. The monaxonic and amphitect shells of the pylomatic type belong to Rhizopoda, which, in swimming or creeping, maintain a definite perpendicular principal axis. The eudipleural development owes its origin to creeping in a particular direction. The specific evolution of the form-type once selected is independent of the shell-material; in the selection of this type, however, the latter plays an important part, and this applies in a still higher

* Journ. de Bot. (Morot), iii. (1889) pp. 189–94 (2 figs.).
† Comptes Rendus, cix. (1889) pp. 578–9.
‡ Amer. Mon. Micr. Journ., x. (1889) pp. 145–6.
§ Biol. Centralbl., ix. (1889) pp. 333–52.

degree to the growth-type, for the structural material plays an important part in determining the mode of growth of the Rhizopod shell.

Some of the Thalamophora construct their shells of agglutinated foreign bodies, partly of inorganic (sand, mud), and partly of organic nature, while the greater part of the Thalamophoran shells are formed by secretion of carbonate of lime; the skeletons of the Radiolaria consist of silica. As the two first constituents are far less firm than silica, there is a corresponding difference in the habit and mode of construction of the two great primary groups of the Rhizopoda. Even a slight examination shows that the shells of the Thalamophora are far stouter and more massive than the Radiolarian skeletons, which are often exceedingly complicated, graceful, and elegant. The comparatively soft material which is employed by the former does not permit them safely to erect such airy and complicated structures as the skeletons of the latter, which are composed of solid, more or less elastic, siliceous rods.

The distinctions, however, are still more profound, and affect the whole structural plan of the shells and skeletons. In the Radiolaria both growth-types appear widely distributed, but there is an unmistakable preponderance of the concentric growth, while in the Thalamophora the terminal growth-type is exclusively represented. The cause of this difference is to be found in the fact that these two modes of construction make different demands upon the solidity of the material; it is in the essence of the perforate-concentric mode of construction that it requires to be carried out more lightly. As there is no principal orifice the passage of the sarcode is by the pores of the shell, which must not be too narrow, nor the intervening skeletal parts too massive; further, the union of the latticed spheres concentrically nested one within the other is only possible by means of free radial rods, which, again, must not exceed a certain thickness. The conditions of the pylomatic-terminal mode of construction are, obviously, very different.

The author quotes with approval the recent speculations of Neumayr, as he proposes a phylogeny which agrees better with both the morphological and palæontological facts than is the case with the older systems.

In conclusion, attention is drawn to the interesting and significant fact that Molluscan and Thalamophoran shells follow the same laws of circumvolution. This form must have its cause, not in the nature of the organisms, but in the circumstances of the external world, and is dependent on statical and mechanical requirements.

Rhizopod-Fauna of Bay of Kiel.*—Dr. K. Möbius, who has already described the Infusoria of the Bay of Kiel,† now gives an account of the Rhizopoda; of the latter twenty-five species are now known, and as sixty-three Infusoria have been described, it is clear that there are more than eighty-eight Protozoa in this bay. In *Actinolopus pedunculatus*, as F. E. Schulze observed, the nucleus is near the top of the more acute pole of the oviform body. *Vampyrella pallida* sp. n. is provided with pseudopodia which have the power of moving from side to side in pendulum-fashion; it lives chiefly on the small diatom *Navicula elliptica*;

* Phys. Abhandl. K. Akad. Wiss. Berlin, 1888 (1889) Abh. ii., 31 pp., 5 pls.
† *Ante*, p. 234.

the species requires further investigation. A rather full account is given of the incompletely known *Dendrophrya radiata*, first described by Strethill Wright. *Gromia gracilis* is a new species with an oviform or spherical, colourless test; the protoplasm is colourless, and the pseudopodial stalk has no roots. There are a number of vacuoles, one contractile vesicle, and one nucleus. Reproduction is effected by transverse and probably also by longitudinal division. *Trichosphrœium sieboldi* is described at some length, and a special group is made for it, which is called Trichosa, and thus defined:—Pseudopodia lobate; test flexible, with pore-canals, but no large orifice and bilaminate; the outer layer consists of special organic rodlets, the inner of a chitinous membrane. The group occupies a low position among the Testacea, and appears to form a connecting link between the Perforata and the Amœbæa. A description is given of *Biomyxa vagans*, but it remains to be shown whether it is an adult Rhizopod, or a developmental stage in the life of a Protist. A new species of *Amœba*—*A. prehensilis*—is shortly described.

Nuclearia delicatula.*—M. A. Astari finds that, in its vegetative phase, *Nuclearia delicatula* is spherical, pyriform, oviform, and elongated, but it is often irregular in form, and may be lobed. The protoplasm is generally rich in vacuoles, and contains several nuclei. Needle-shaped, simple, rarely branched, pseudopodia are given off from the body, which is often surrounded by a mucous investment, the surface of which is covered with granules.

The ground-mass of the body is formed by a homogeneous and hyaline substance, the hyaloplasm; in this, small granules are imbedded, which together make up the granular plasma; this latter is distributed regularly through the body; as it generally reaches the periphery there is no division of the body into an outer and an inner layer. The number of food-vacuoles varies from four or five to so many that they give a frothy appearance to the body, and they vary also considerably in size. The author has failed to find contractile vacuoles.

Specimens may be quite colourless, or bright red, yellowish or brownish; and the coloration of the body is dependent on the food. The gelatinous investment is coloured reddish by Hanstein's anilin-violet, and can, as a rule, be seen only in free-living individuals; *Nuclearice* which are put into the moist chamber lose their investment, and become naked.

The process of ingestion of food is very interesting; when a short filament of *Oscillaria* is seized, the organism ordinarily draws the alga as a whole into the interior of its body; to effect this it approaches the alga and touches it with its pseudopodia, and then gradually flows round it; if the algar filament is too long, the *Nuclearia* either seizes part of it, when the rest remains outside its body or breaks off, or it takes it in a different way. It places itself at the end of the filament, and the granular protoplasm begins to be depressed; after a short time the cell-membrane disappears at the point of junction, as though it had been destroyed; the granular structures of the cell-contents alter their position, and pass into the interior of the body of the *Nuclearia*. Later on, the same fate happens to the second cell, then to the third, and so on. In another case the author observed that a *Nuclearia* had attached itself

* Zool. Anzeig., xii. (1889) pp. 408-16.

closely to the end of a filament of *Oscillaria*, and flowed around two of its cells; after some time the contents of these two cells passed, in the form of two granular layers, into the interior of the body of the *Nuclearia*; the remains of the cell-membrane were seen on the filament.

In all the cases observed, the *Nuclearia* attacked the filament from the end; the cell-membrane was dissolved at the point of junction with the hyaloplasm, and probably under the influence of some secretion of that layer. The undigested remains are got rid of in the form of balls of various sizes and colours. In one case the hyaloplasm was seen to send out outgrowths, in the interior of which small granules were inclosed; these outgrowths elongated, got narrower and narrower, and were again drawn in, but the granules remained outside the body of the *Nuclearia*.

In conclusion, the author deals with the phenomena of fusion and division; under certain, but not yet understood, conditions, *Nuclearicæ* fuse with one another; it generally happens when several individuals are collected together; the individuals that fuse are rarely of the same size, one being generally larger than the other. Division is also to be seen, but only in large individuals which are probably plasmodia formed by repeated fusions.

Nuclearia is most closely allied to *Vampyrella*, but the systematic position of these and some allied forms is still uncertain; Bütschli places them with the Heliozoa; Zopf is doubtful as to the position of *Vampyrella*; the author thinks they should go with the Myxomycetes.

Reproduction of Foraminifera.*—M. C. Schlumberger thinks that Mr. Brady's observations on *Orbitolites complanata* var. *laciniata*, which formed the subject of a paper in this Society's Transactions,† prove without doubt that *Orbitolites* is viviparous, and that the embryos are formed in the chambers of the adult; to escape they have to injure the parent, but this is of no account, as *Orbitolites* is easily able to repair its "plasmostracum." As to the question of dimorphism, on which MM. Schlumberger and Munier-Chalmas suggested two hypotheses, the observations of Mr. Brady show that the one which explained the dimorphism by supposing that at a given moment the individual absorbs the megalosphere, and replaces it by a new arrangement of more numerous chambers, is the more correct.

Grassia ranarum.‡—Dr. A. Schuberg brings forward evidence to show that *Grassia ranarum*, with regard to whose position in the systematic arrangement of the Ciliate Infusoria there has been some difficulty, is not a definite organism at all. Similar appearances to it may be obtained by scraping the mucous membrane of the frog. On this Prof. B. Grassi § makes some remarks in the way of answer.

* Bull. Soc. Zool France, xiii. (1888) pp. 222–4.
† This Journal, 1888, p. 693.
‡ Biol. Centralbl., ix. (1889) pp. 284–7. § T. c., pp. 424–5.

BOTANY.

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

a. Anatomy.*

(1) Cell-structure and Protoplasm.

Structure of the Cell.†—Dr. F. Noll gives a very useful *résumé* of the more important researches during the last fifteen years on the structure of the vegetable cell.

Nucleus in Dormant Seeds.‡—From an examination of the cell-nucleus in the seeds of a large number of species belonging to a great variety of natural orders, M. O. W. Koeppen has come to the following conclusions:—The best reagent for staining the nucleole is an aqueous solution of methylen-blue, and this is also useful for the nucleus. A nucleus is always present in the embryo cells, and almost always in the cells of the seed which contain reserve-materials; but is wanting in those of the Typhaceæ and Phytolaccaceæ; in the latter it becomes absorbed before the ripening of the seed. In Monocotyledons and Dicotyledons there is almost always only one nucleus in each endosperm-cell; in Coniferæ almost always more than one; in the embryo-cells almost invariably only one. The absolute size of the nucleus varies very greatly according to the species. Its form is usually regular in seeds which contain no starch, very irregular in those which do. On germination the nuclei with irregular form sometimes assume a regular form, sometimes remain unchanged. The nucleus does not perish until after the reserve-materials have passed out of the cell. A nucleole was observed in most cells of the ripe seed which do not contain starch, never in those which do. Its form is always spherical. The nucleus never contains more than one nucleole.

Pollen of the Cycadeæ.§—M. L. Guignard states that the pollen of the Cycadeæ has been studied of recent years by Juranyi and by Treub, who carefully followed the development from the youngest stage, and by Strasburger, who studied the membrane. Certain abnormal or exceptional facts described by Juranyi in relation to nuclear division in the pollen-mother-cells appeared to want confirmation; and incidentally the author's attention has been directed to the structure of the nucleus while in a state of repose. According to Juranyi the longitudinal doubling of the primary segments in *Ceratozamia longifolia* takes place immediately after their arrival at the poles, and not at the stage of the nuclear plate. The author, however, has shown that the doubling takes place at this latter stage. The question as to whether the nucleus in a state of repose incloses a single chromatic filament is then discussed; and the paper concludes by describing in detail the successive stages of structure of the nucleus in a state of repose, and the different stages of division as occurring in *Ceratozamia mexicana*.

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

† Flora, lxxii. (1889) pp. 155-68.

‡ 'Ueb. d. Verhalten d. Zellkernes im ruhenden Samen,' Jena, 1887, 50 pp. See Bot. Centralbl., xxxix. (1889) p. 86.

§ Journ. de Bot. (Morot), iii. (1889) pp. 222-6, 229-36 (1 pl.), and Bull. Soc. Bot. France, xxxvi. (1889) pp. 206-11.

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

Composition of Chlorophyll.*—Prof. G. Arcangeli has repeated Kraus's experiments on chlorophyll with benzol, substituting for the benzol petroleum benzine (*benzina di petrolio*), and has obtained similar results. He concludes that chlorophyll is not a simple compound of two substances, pure chlorophyll and xanthophyll, but rather of a series of green and a series of yellow pigments.

Composition of Tannin.†—Commenting on Kraus's paper ‡ on the physiology of tannin, Herr F. Reinitzer states that under the name of tannin a variety of substances are known in vegetable physiology, which by no means exhibit similar chemical reactions. Thus the tannin of oak-apples consists of a mixture of digallic acid and a glucoside of digallic acid. He suggests that the terms "tannins" and "tannic acids" should be banished from vegetable physiology and vegetable chemistry.

Sphero-crystals.§—M. E. Rodier states that in *Senecio vulgaris* sphero-crystals are produced in all the tissues of the stem, but principally in the cortical and medullary parenchyme. They are more regularly spherical than those of inulin, but are arranged in nearly the same manner in the cells. The colour of these bodies is a more or less deep yellow. Anilin colours do not affect spherocrystals; but they are easily soluble in cold, and still more readily in hot water. When treated with ammonium oxalate, they are destroyed and replaced by crystals of calcium oxalate, thus showing that spherocrystals contain lime. By the application of various reagents it may be seen that spherocrystals are composed of a nucleus and an amorphous envelope, probably of organic nature, separated by a crystalline cortex containing lime.

Mucilage in the Endosperm of Leguminosæ. ‖—Herr H. Nadelmann states that the mucilage which is frequently found in the cells of the endosperm of Leguminosæ, together with starch, aleurone, and a fatty oil, serves in the first place as a reserve food-material, the secondary thickenings of the cell-wall which are composed of cellulose being absorbed and consumed in the process of germination. They are produced directly in the form of mucilage, and not as the result of a modification of cellulose. The secondary thickenings, which often occur also in the cells of the cotyledons, are, on the other hand, never composed of mucilage.

Starch in the Epiderm.¶—Prof. R. Pirotta finds, in several species of *Rhamnus*, considerable quantities of starch in the epidermal cells, where it remains during the dead season, to be used up again on the resumption of vegetative activity. The epiderm appears, therefore, to act, in these cases, as a reservoir of starch for purposes of nutrition.

Gluten in the Grain of Corn.**—According to Herr W. Johannsen, gluten forms the main portion of the protoplasm in the amylaceous endosperm-cells of wheat, and is not the result of the action of a ferment.

* Malpighia, iii. (1889) pp. 3–14.
† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 187–96.
‡ Cf. this Journal, *ante*, p. 654. § Comptes Rendus, cviii. (1889) pp. 906–9.
‖ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 248–55.
¶ Malpighia, iii. (1889) pp. 61–6.
** Résumé du compte-rendu d. travaux d. laboratoire d. Carlsberg, ii. (1888) pp. 199–208 (2 figs.). See Bot. Centralbl., xxxix. (1889) p. 22.

The so-called "gluten-layer" beneath the pericarp contains neither gluten nor any ferment, but small grains of a nitrogenous substance imbedded in fatty protoplasm, as well as diastase.

Formation of Calcium oxalate in Plants.*—Dr. C. Acqua discusses the mode and place of formation of the crystals of calcium oxalate in plants. He decides against the hypothesis that it may be formed in all the turgid cells of the parenchyme, from whence it is carried in the cell-sap to those where it is ultimately deposited in the crystalline form. He believes, on the contrary, that the calcium oxalate, though not the oxalic acid, is formed in the crystalliferous cells. The acid may be formed in all the turgid cells of the cortical and medullary parenchyme, where it combines with potassium, and circulates chiefly through the intercellular spaces. It is there prevented from combining with the calcium-salts in the cell-sap by the coating of ectoplasm; while the cell-walls of the crystalliferous cells possess the property of accumulating in them calcium-salts, which then decompose the potassium oxalate, and cause the deposition of crystals of calcium oxalate. This hypothesis is confirmed especially by observations on *Mesembryanthemum acinaciforme* and *Euonymus japonicus*.

Prof. A. Poli † replies to strictures made by Dr. Acqua on his previous writings on this subject.

Calcium oxalate in Plants.‡—In opposition to the statement of Schimper, Dr. C. Wehmer finds that in *Symphoricarpus*, *Alnus*, and *Cratægus*, there is no transference of the calcium oxalate from the leaves to the leaf-stalk, branch, or stem, nor from the mesophyll to the vascular bundles; but that, on the other hand, the oldest leaves always contain the largest amount of this salt.

In *Cratægus* the buds are found to be filled with calcium oxalate in the autumn; and this is not deposited with the first growth in spring; but only at a later period of the formation of the new organs.

The absence of calcium oxalate in certain parasites (*Rafflesia*, *Lathræa*, *Cuscuta*, *Cassytha*) he attributes to the suppression of the production of plastic substances from distant organs.

In reply, Dr. F. G. Kohl § points out that the explanation is hardly satisfactory, since we have to do with the absence, not of oxalic acid, but only of calcium oxalate; and that *Lathræa squamaria* does at certain times contain large quantities of starch. He also dissents from Wehmer's conclusions as to the distribution of calcium oxalate in *Symphoricarpus*, &c.

Perfume of the Rose.‖—M. R. Blondel states that the odour of the rose is found to be principally developed in the group *Centifolia*, and particularly in *R. centifolia*. The *Canina* group possesses an analogous odour, which is, however, generally much more feeble. The hybrids produced by crossing Tea Roses (*R. fragrans*) and Bengalese Roses (*R. semperflorens*) with *R. centifolia* give a great variety of odours; while the Noisette Roses (hybrids of *R. moschata*

* Malpighia, iii. (1889) pp. 17–43, 160–6 (1 pl. and 1 fig.). Cf. this Journal, *ante*, p. 655.

† T. c., pp. 173–5.

‡ Bot. Ztg., xlvii. (1889) pp. 141–55, 169–78; Bot. Centralbl., xxxviii. (1889) pp. 648–9; and Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 216–33 (1 pl.).

§ Bot. Centralbl., xxxviii. (1889) pp. 649–52.

‖ Bull. Soc. Bot. France, xxxvi. (1889) pp. 107–13.

and *R. semperflorens*) are generally scentless. In the *Banksia* group, *R. Banksia alba* possesses a very pronounced odour of violets, while *R. Banksia lutea* has no marked odour. The *Cinnamomeæ*, with one or two exceptions, do not possess a strong odour, and the *Pimpinellifoliæ* are likewise almost scentless. In the *Villosæ* the flowers are nearly scentless, but the leaves are glandular, and omit an odour of terebinthin (*R. villosa*). The section *Rubiginosæ* are also remarkable only on account of the peculiar perfume emitted by the leaves of several species. The author then describes in detail the tissues inclosing the fragrant principle. In the petals the essential oil resides in the cells of the two layers of the epiderm; its presence may be easily detected by using osmic acid.

Odour of the Glands in Rosa.*—M. F. Crépin calls attention to the interest connected with the substances contained in the glands of different species of *Rosa*, which deserve closer observation than they have at present received. He points out that the odour of the substance contained in the glands of the sweet-briar (*R. rubiginosa*) and of the species nearly allied to it which make up the section Rubiginæ, is totally different from that of all other species of the genus.

(3) Structure of Tissues.

Laticiferous Tubes.†—Mr. P. Groom has investigated the distribution of laticiferous tubes, with reference to their function, in several species of Euphorbiaceæ, Papayaceæ, Artocarpeæ, Asclepiadeæ, and Compositæ. He finds that the tubes may be distributed throughout the whole of the leaf, and may end in contact both with the epiderm and the mesophyll. In some leaves the endings of the tubes are chiefly in contact with the epiderm; in others chiefly or exclusively away from it. In the leaves the tubes may leave the assimilating tissue altogether, as they do in the Artocarpeæ, when they pass through the aquiferous tissue to the epiderm. There is, therefore, no essential connection between the endings of the laticiferous tubes and any particular tissue of the leaf. From these facts the author draws the conclusion that no conduction of carbohydrates takes place through the laticiferous tubes, as has been supposed by some, this process being effected, in the leaves, mainly through the parenchyme of the veins.

Vesicular Vessels of the Onion.‡—Mr. A. B. Rendle finds that the structures which go by this name are not correctly so-called, being enlarged cells in which no cell-fusion has taken place. He proposes that they should be termed in future *laticiferous cells.* Their resemblance to sieve-tubes is simply structural; in the great majority of instances the pits in their walls are not perforated. With regard to their function, they contain no ordinary food-material, and have no connection either with the assimilating parenchyme or the vascular bundles. Their contents is a more or less granular turbid fluid of the nature of latex, and must probably be regarded simply as an excretory product.

Intercellular Spaces in the Tegument of the Seed of Papilionaceæ.§—Dr. O. Mattirolo and Sig. L. Buscalioni find in the tegument of the

* CR. Soc. R. Bot. Belgique, 1889, pp. 64–7.
† Ann. of Bot., iii. (1889) pp. 157–68 (1 pl.).
‡ T. c., pp. 169–77 (1 pl.).
§ Malpighia, iii. (1889) pp. 143–59 (1 pl.).

seed of many species of Papilionaceæ a structure hitherto known only among Ferns; for the wall of the intercellular spaces is clothed with a number of filiform processes. These processes are most common in the neighbourhood of the micropyle and hilum, and, when most fully developed, take the form of capitate rods, or sometimes of elongated filaments. The microchemical reactions of these substances are given in detail; and the authors conclude from them that these rods are identical in nature with those of the Marattiaceæ, and are formed of a substance different from cellulose; or rather, of two different substances, one of which composes the mass of the process, the other its investing membrane; neither are they composed of protoplasm. The substance of these processes, like the secretion of glands, is deposited in the cell-wall and investing membrane, which latter is continuous with the investing membrane of the intercellular space.

Strengthening Apparatus in the Stem of Saxifragaceæ.*—M. Thouvenin describes the variations in the structure of the stereome to be found in the underground stems of Saxifragaceæ, which he groups under eight heads, dependent on the degree of development of the pith, cortex, and medullary rays, and on the structure of the pericycle and endoderm.

Radial Union of Vessels and Wood-parenchyme.†—Herr F. Gnentsch describes several different ways in which the vessels of two successive annual rings unite, as well as differences in the distribution of the vessels. He draws the general conclusion that the annual ring is not so completely closed as is usually supposed. On the contrary, the vessels, one of the most important constituents of the xylem, regularly unite at the boundary of two successive rings, either directly or by tracheides. Through this union a regular interchange of formative material takes place, especially in the spring, when the medullary rays are unable to perform this function to any large extent. The wood-parenchyme-cells, on the other hand, are in general concerned only with tangential and not with radial conduction.

Formation of healing Periderm.‡—Herr L. Kny has investigated the influence of light, temperature, moisture, pressure, and other external agencies on the formation of periderm which follows the infliction of injuries on the tubers of many plants. He finds that the cell-divisions which inaugurate the formation of the periderm take place indifferently in diffused daylight and when light is excluded; and that the later processes and the suberization in the periderm-cells are not materially influenced by the amount of light. These cell-divisions are promoted by a medium moisture of the air. The position of the cut surface, whether facing upwards or downwards, or whether vertical or horizontal, does not affect the cell-division. The free oxygen of the air is essential, both for the commencement of the cell-division and for the formation of cork.

Formation and Development of Libriform Fibres.§—Herr A. Wieler has investigated the phenomena connected with the development of the libriform fibres in the xylem of the stem of dicotyledonous plants,

* Bull. Soc. Bot. France, xxxvi. (1889) pp. 125–33.

† 'Ueb. radiale Verbindungen d. Gefässe u. d. Holz-parenchyms u.s.w.,' Regensburg, 1888. See Bot. Centralbl., xxxix. (1889) p. 34.

‡ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 154–68.

§ Bot. Ztg., xlvii. (1889) pp. 517–28, 533–40, 549–61 (1 pl.).

especially *Urtica dioica*, *Robinia pseudacacia*, *Quercus sessiliflora*, and *Phaseolus multiflorus*, and finds the development of this tissue greatly dependent on external conditions. These conditions determine the proportion in which the various tissues or kinds of cells are developed from the initial cambium-cells; but the extent of this variability is limited for each species. The formation of the libriform fibres, or of the fibre-cells which replace them, appears to be in all cases a mechanical one.

Secondary Medullary Rays.*—Herr E. Schmidt has investigated the mode of formation of the secondary medullary rays, especially in *Pinus sylvestris*. They originate in the cambium, but not from any sudden change; rather as the final result of a series of changes gradually leading up to them.

Foliar Medullary Bundles of Ficus.†—Conte Dr. L. Macartili finds no trace of medullary bundles in the stem of any species of *Ficus* examined; on the other hand, they are numerous in the leaf-stalk and veins of the leaf. They always originate from the node, and are portions of leptome which separate, for a longer or shorter distance, from the leptome of the normal bundles, towards which they then turn, to be reunited with them.

(4) Structure of Organs.

Ovuliferous Scales of Coniferæ.‡—Prof. F. Delpino discusses the morphological value of the ovuliferous scales of the Abietineæ and other Coniferæ. He states that in the Pteridophyta, Gymnosperms, and Angiosperms the evolution of the carpid or fertile leaf is manifestly homologous, with slight differences. The carpid or fertile leaf must be regarded as a phyllome ideally divisible into three, and frequently actually tripartite, with the median division sterile, and the two lateral divisions fertile and ovuliferous or sporangiferous. If the phyllome remains entire we have the pleurosporangium of many ferns, or pleurospermy, which is normal in the Cycadeæ and in nearly all Angiosperms. But frequently in the fertile leaf the sporangiferous divisions separate from the median sterile plane of division into a bundle opposed and superposed to the median division, as occurs in *Aneimia*. It may then happen that, from the first, all the fertile divisions coalesce into a single fertile body opposed and superposed to the sterile division; and to this phenomenon the author applies the term *antisporangism* in Pteridophyta, *antispermy* in Phanerogams.

Antisporangism occurs in at least two sections of the Pteridophyta, and independently of one another—in the Marattiaceæ and the Ophioglossaceæ. The axillary sporangism of the Lycopodiaceæ is also a case of antisporangism reduced to its simplest form, with the production of three sporanges in *Psilotum*, two in *Tmesipteris*, and only one in *Lycopodium*, *Selaginella*, and *Phylloglossum*. The axillary sporangism of the Isoeteæ is derived directly from the antisporangism of *Ophioglossum*.

The antispermism of the Gymnosperms is manifested in *Salisburia*, in the archaic *Sciadopitys*, and in the Abietineæ, Cupressineæ, Araucarieæ, and Podocarpeæ, but with a singular difference of development in the median and the two fertile portions of the carpid. In the

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 143-51 (1 pl.).
† Malpighia, iii. (1889) pp. 129-33. ‡ T. c., pp. 97-100.

Abietineæ, Cupressineæ, and *Sciadopitys* the median region of the carpid (bract of authors) is very small, while the two placentæ are thick and large, and are fused into one body. In the Podocarpeæ, on the other hand, and especially in *Araucaria*, the median region is well developed, the fertile body small and more or less connate with the median region. The barren leaf of *Ophioglossum* stands in precisely the same relation to its fertile leaf as the barren leaf or median barren portion of the carpid of *Salisburia* to its fertile portion.

Although pleurospermy is far the most prevalent phenomenon in Angiosperms, yet there are instances of antispermy, as in the true central placentation of the Primulaceæ and Plumbagineæ. Here there are five tripartite carpids. The five median portions coalesce and form the unilocular ovary with its single style or five styles; the ten lateral ovuliferous portions combine into a large central placentary body, resulting evidently from the fusion of five antispermic bodies. Antispermy occurs also in the Juglandeæ, Loranthaceæ, and Santalaceæ.

Sensitive Stamens in Compositæ.*—Prof. B. D. Halsted records the occurrence of sensitive or elastic stamens in the following species of Compositæ:—*Echinacea angustifolia*, *Heliopsis lævis*, *Lepachys pinnata*, and *Rudbeckia hirta*. The movements appear to be in all cases connected with the distribution of the pollen.

Bracteoles of the Involucre in the Cynarocephalæ.†—M. L. Daniel describes the variations in the nature of the foliar parenchyme in this section of Compositæ. The absence of stomates in the parts of the bract placed in obscurity is a consequence of the sclerification of the epiderm, and not of the obscurity. The structure of the parenchyme depends on the influence of the surroundings in which the bract or bracteole is placed.

Secund Inflorescence.‡—Tracing the development of various instances of this mode of inflorescence (excluding the scorpioid), Mr. T. Meehan finds that it is common in perennial, but not in annual plants. He believes it to be a comparatively recent stage in evolution, in which a geotropic stem has assumed an erect condition, and arises from the alternate twisting of the pedicels in contrary directions.

Ovaries and Achenes of the Rose.§—M. F. Crepin states that in the sections of *Rosæ* known as *Carolinæ*, the ovules, and later the achenes, will be found situated at the bottom of the receptacle, while in *Cinnamomeæ* the ovaries or their achenes will be found situated not only at the bottom, but also to a certain height on the lateral walls. This affords a character for separating the section *Carolinæ* from the *Cinnamomeæ*.

Achenes of Coreopsis.‖—Mr. J. N. Rose describes the various forms of achene (cypsela) to be found in *Coreopsis*, one of the Compositæ. They may be flat or somewhat four-sided, straight or curved, orbicular to linear-oblong in outline, glabrous to pubescent, winged or wingless, with entire or laciniate toothed margin, the apex truncate or emarginate, the pappus of two awns or of teeth or scales, these generally hispid on

* Bot. Gazette, xiv. (1889) pp. 151–2. Cf. this Journal, *ante*, p. 544.

† Bull. Soc. Bot. France, xxxvi. (1889) pp. 133–43. Cf. this Journal, *ante*, p. 408.

‡ Proc. Acad. Nat. Sci. Philad., 1889, pp. 53–6 (2 figs.).

§ CR. Soc. Bot. Belgique, 1889, pp. 87–8.

‖ Bot. Gazette, xiv. (1889) pp. 145–51 (1 pl.).

the upper part; or all these are wanting. A list of the species of *Coreopsis* is given, with descriptions founded on characters drawn from the achenes.

Floating-organs.*—After a discussion of the mathematical problems connected with contrivances for hindering the descent to the ground of parts of plants, Herr H. Dingler classifies the various kinds of floating organs under twelve distinct heads, viz.:—(1) Dust-like (Schizomycetes, spores of Fungi, Vascular Cryptogams, &c., the pollen-grains of anemophilous plants); (2) Grain-like (seeds of Papaveraceæ, Orobanchaceæ, &c.); (3) Furnished with bladders (fruit of *Valerianella*, seeds of Orchideæ, achenes of *Cynara Scolymus*, &c). : (4) Hair-like (many Bromeliaceæ); (5) Disc-like and flat (fruit of elm, seeds of some Irideæ and Liliaceæ); (6) Disc-like and convex (fruit of *Paliurus aculeatus;* seed of *Eccremocarpus scaber;* (7) Parachute-like (achenes of Dipsaceæ, Plumbagineæ, and many Compositæ; (8) Cylindrical and winged (fruit of many Polygonaceæ and of *Halesia*); (9 and 10) With ridges which give a sail-like form (*Ailanthus* and some Bignoniaceæ and Ternstrœmiaceæ); (11 and 12) Samaras and other fruits and seeds which fall with a helicoid motion (samara of ash, maple, &c., fruit of *Liriodendron tulipifera*, seeds of many Coniferæ).

Pitcher of Nepenthes.†—From a study of the development of the leaf of several species of *Nepenthes*, Prof. F. O. Bower has come to the conclusion that the leaf is not a simple but a branched one, the space at the back of the lid being its organic apex; the whole leaf consists of:—(1) a phyllopode, winged throughout its whole length, terminating in the spur, and developing the pitcher itself as an involution of its upper surface; and (2) a pair of pinnæ, which show congenital coalescence across the frontal face of the phyllopode, and constitute the lid of the pitcher. By *phyllopode* he understands the main axis of the leaf (including petiole), exclusive of all its branches.

Pitchered Insectivorous Plants.‡—From observations on species of *Nepenthes*, *Heliamphora*, *Sarracenia*, *Darlingtonia*, and *Cephalotus*, Dr. J. M. Macfarlane has also come to the conclusion that in the first four genera the leaf is compound, and consists of from two to five pairs of leaflets, exhibiting a marked tendency to dorsal fusion of the leaflets from apex to base. This is demonstrated by comparison of the seedling with the adult leaves. The pitcher is, in these genera, a deep dorsal involution of the mid-rib just above the termination of the fused under pair of leaflets. The lid itself is made up of two leaflets produced on either side of the median mid-rib, which may afterwards be excurrent, or the leaflets may fuse distally to form a median dorsal process. The pitchers of *Cephalotus* appear to differ in every respect from those of the other genera, and probably represent one of a chain of forms otherwise lost.

Homology of Stipules.§—Studying the development of the parts of the flower in *Magnolia* and many other plants, Mr. T. Meehan assigns

* 'Die Bewegung. d. pflanzlichen Flugorgane,' München, 1889, 342 pp. and 8 pls. See Flora, lxxii. (1889) pp. 169–79.

† Ann. of Bot., iii. (1889) pp. 239–52 (1 pl.).

‡ T. c., pp. 253–66 (1 pl.). Cf. this Journal, *ante*, p. 408.

§ Proc. Acad. Nat. Sci. Philad., 1889, pp. 62–4.

reasons for regarding the petals and sepals, not as modified entire leaves, but as modifications of the base of the petiole or stipule, the main purpose of both organs being the protection of the tender parts of the flower. It is not uncommon in the rose for the ordinarily suppressed lamina of the leaf to reappear, in cultivation, at the apex of the sepals.

Stem and Leaf of Utricularia.*—According to Prof. K. Goebel several exotic species of *Utricularia* exhibit a remarkable absence of differentiation between axial and appendicular organs. We have here leaves which have the power of developing into organs, the stolons, which have all the characters of a shoot; while, on the other hand, in some species, large cylindrical bladder-bearing stolons become flattened off at their apices into leaves.

Opening and Closing of Stomates.†—Prof. S. H. Vines assigns reasons for his conclusion, derived from observation of the phenomena connected with the opening and closing of stomates, that the opening is not due to stimulation by light or any other agent of the irritable protoplasm of the guard-cells, but is a purely passive one, depending on the formation of osmotically active organic substances in the chlorophyllaceous guard-cells when exposed to light; while, on the other hand, their closing is an active process determined by the stimulating influence of a certain relation between loss and supply of water on the irritable protoplasm of the guard-cells.

Colleters and Glands of Gunnera.‡—Herr P. Merker describes the colleters on the leaves of various species of *Gunnera* as being formed originally of three epidermal cells, other parenchymatous cells immediately beneath the epiderm subsequently taking part in their formation, and forming their foot. The mucilage in the glands of the stem is the seat of the peculiar colonies of *Nostoc* so often found in several species. The author does not regard these as carrying on a symbiotic existence, but rather as parasitic, and inflicting injury on the host.

Abnormal Formation of Rhizome.§—Herr H. Vöchting describes the production of rhizomes on aerial stems of *Stachys tuberifera* and *S. palustris*. These resembled the normal rhizomes in all essential particulars, differing chiefly in the greater length of the internodes, in the scales being replaced by leaves, and in the presence of chlorophyll. They serve to show the close morphological connection between underground and aerial stems.

Aerating Roots.‖—Prof. W. P. Wilson describes the mode of growth in the excrescences known as "knees" which characterize the American cypress, *Taxodium distichum*, when growing in swamps. He finds that they are undoubtedly for the purpose of aerating the plant; and that it is quite possible to produce similar aerating organs in other plants by growing them in very swampy localities.

* Flora, lxxii. (1889) pp. 291–7 (1 pl.). Cf. this Journal, *ante*, p. 545.
† Ann. of Bot., iii. (1889) pp. 271–4. ‡ Flora, lxxii. (1889) pp. 211–32 (3 pls.).
§ Bot. Ztg., xlvii. (1889) pp. 501–7 (1 pl.).
‖ Proc. Acad. Nat. Sci. Philad., 1889, pp. 67–9.

β. Physiology.*

(1) Reproduction and Germination.

Flowers and Insects.†—Mr. C. Robertson describes the mode of fertilization and the insect visitors in the following American plants:—*Delphinium tricorne*, *Nuphar advena*, *Nymphæa tuberosa*, *N. odorata*, *Dicentra Cucullaria*, *Viola pubescens*, *V. palmata* var. *cucullata*, *V. striata*, *V. pedata* var. *bicolor*, *V. lanceolata*, *Claytonia virginica*. The inversion of the flower of most species of *Viola* appears to be particularly favourable to bees of the genus *Osmia*, the flowers of *V. pubescens*, *palmata*, and *striata* being specially adapted to them. The bearded violets are sternotribe, while *V. pedata*, which is mainly visited by long-tongued bees, has become nototribe.

Dimorphism of Polygonum.‡—Mr. T. Meehan finds several American species of *Polygonum* (including the European *P. Persicaria*, *aviculare*, and *Hydropiper*) to be dimorphic, with larger and smaller flowers. The smaller flowers are perfectly formed, and are abundantly nectariferous and polliniferous, and apparently constructed for self-fertilization, but never produce seed. The larger flowers are apparently adapted for cross-fertilization, and are abundantly fertile, but are never visited by insects. They are, in fact, fertilized in the bud, and are frequently cleistogamous.

Properties of Hybrids.§—Dr. F. Hildebrand gives details of a long series of experiments on hybridization, chiefly between different species of *Cistus*, *Abutilon*, *Chamædorea*, and *Oxalis*. In the case of *Chamædorea*, a genus of palms, he finds the hybrids to be perfectly fertile with one another, although the original parents belonged to sharply differentiated species. In *Oxalis* the hybrid presented a mingling of the character of the parents in an immense variety of ways. The hybrids generally exhibited a more luxuriant growth than the pure forms, and blossomed earlier.

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

Influence of "Ringing" on Growth.‖—According to Herr T. Müller, "ringing" of branches produces a more active growth above, a less active growth below the ring; this is chiefly displayed in the wood, less in the secondary cortex and periderm. Starch is usually entirely absent from the portion below the ring, and tannin is more abundant above than below, while the reverse is the case with calcium oxalate.

Obtaining of Nitrogen by Gramineæ and Leguminosæ.¶—Herren H. Hellriegel and H. Willfarth maintain, as the result of a long series of experiments, an essential difference in the mode in which Gramineæ and Leguminosæ obtain their nitrogen. The growth of barley and oats is in direct proportion to the amount of nitrates contained in the soil, and they

* This subdivision contains (1) Reproduction and Germination; (2) Nutrition and Growth (including Movements of Fluids); (3) Irritability; and (4) Chemical Changes (including Respiration and Fermentation).

† Bot. Gazette, xiv. (1889) pp. 120–6, 172–8 (4 figs.).

‡ Proc. Acad. Nat. Sci. Philad., 1889, pp. 59–61.

§ Jenaisch. Zeitschr. Naturw., xxiii. (1889) pp. 413–548 (2 pls.).

‖ 'Ueb. d. Einfluss d. Ringelschnittes auf d. Dickenwachsthum u. d. Stoffvertheilung,' Halle, 1888, 53 pp. See Bot. Centralbl., xxxix. (1889) p. 31.

¶ 'Unters. üb. d. Stickstoffnahrung d. Gramineen u. Leguminosen,' Berlin, 1888, 234 pp. and 6 pls. See Bot. Centralbl., xxxix. (1889) p. 138; and Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 138–43.

appear to have no other source of nitrogen; while, on the other hand, this is not the case with vetches, which may grow luxuriantly in a soil containing no nitrogen. They must, therefore, obtain this element from some other source, which appears to be the free nitrogen of the atmosphere. They are not, however, able to obtain it directly from the air; this is effected by microbes, which carry on a symbiotic existence with several species of Leguminosæ, usually stored up in special tubercles on the root; they are not able to make use, for this purpose, of the microbes contained in the soil.

Power of plants to absorb Nitrogen from the air.*—Herr B. Frank replies to the statements of Hellriegel and Willfarth, and maintains his previous assertion,† that all plants possess the power, under certain circumstances, of assimilating directly the free nitrogen of the air. The contrary results obtained by Hellriegel and Willfarth in the case of plants belonging to any other order than the Leguminosæ, he attributes to the plants being in a weak or unhealthy condition, in which state they are entirely dependent for their nutrition on previously formed organic nitrogenous compounds. He points out that there is no single direct observation to connect the "bacteroids" in the root-tubers of Leguminosæ with this supposed function, that the fact of their being living organisms is subject to very considerable doubt, and that their structure and mode of life are altogether different from those of "mycorhiza," in which a symbiosis between the fungus and the enveloped root has been satisfactorily demonstrated.

Movements of Gases in Plants.‡—Herr P. Kruticki finds the permeability of different plants for air to vary exceedingly, and to bear no relationship to their permeability for water. In winter the air contained in the branches contains less oxygen and more nitrogen, and a considerably larger proportion of carbon dioxide than atmospheric air. At the beginning of spring the proportion of oxygen increases, while that of carbon dioxide decreases; until, when the buds begin to open, the composition of the contained air is nearly that of the surrounding atmosphere. This indicates a decrease in the activity of the physiological processes within the plant in the winter.

Curvature of Growing Organs.§—Pursuing his investigations on this subject, and replying to the observations of Noll,‖ Herr J. Wortmann sums up the main results as follows:—The three variables which determine the growth of a cell are turgor, extensibility of the cell-wall, and the presence or access of water; every alteration in any one of these forces brings about a change in the growth. As long as a cell grows, the production of osmotic substances in the cell-sap and of elements of the cell-wall, and absorption of water must continue. The increased extensibility of the cell-wall of the under-side of a cell which is curving upwards (epinastic) is the result of a diminished formation of cell-wall, while the diminished extensibility of the cell-wall of the upper side is the result of an increased formation of cell-wall.

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 234-47.

† Cf. this Journal, *ante*, p. 550.

‡ Script. Bot. Horti Univ. Imp. Petropolitanæ, ii. (1888) pp. 115-53. See Bot. Centralbl., xxxix. (1889) p. 30.

§ Bot. Ztg., xlvii. (1889) pp. 453-61, 469-80, 485-92. Cf. this Journal, *ante*, p. 92.

‖ Cf. this Journal, *ante*, p. 413.

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

Influence of Oxygen in the Decomposition of Albuminoids.*—Prof. W. Palladin maintains the view that the carbohydrates, especially starch and cellulose, result from the decomposition of the proteids; the amides, especially asparagin, being secondary products. This is the cause of the accumulation of asparagin during germination, which is again converted into proteid when the newly-formed carbohydrates are assimilated. The author dissents entirely from the theory of Pfeffer that the nitrogenous substances are translated through the plant in the form of asparagin. The breaking up of proteids into asparagin and carbohydrates must be accompanied by a considerable consumption of oxygen, which is actually the case. In the respiration, especially of germinating seeds, the proportion $\frac{CO_2}{O_2}$ is considerably less than unity. The carbohydrates must therefore be regarded as products of oxidation of the albuminoids.

Formation of Starch out of Sugar.†—Herr W. Saposchnikoff has determined the direct production of starch out of cane-sugar in the leaves of many plants, and not as the result of the metastasis of other substances already present in the leaf.

Alcoholic Fermentation of Milk.‡—It had been shown by Duclaux and Adametz, that the alcoholic fermentation of milk can be effected without inducing coagulation by means of certain yeasts. It was afterwards found that milk fermented with the yeast described by Duclaux coagulated on boiling. M. Martinaud now states that under certain conditions the two phenomena, the alcoholic fermentation of the sugar and the coagulation of the milk, can be brought about with any kind of yeast. If a 10 per cent. solution of glucose or maltose, added to milk in quantities varying from 10 to 80 per cent., be sown with the Duclaux ferment, or with any one of the following species of *Saccharomyces*, *cerevisiæ*, *ellipsoideus*, *pastorianus*, or *apiculatus*, the milk coagulates in from 17 to 116 hours. The same phenomenon is observed if saccharose be used, except with *S. apiculatus*.

The conditions which retarded or favoured this coagulation were examined by varying the quantities of water and of sugar, separately and together, and also by adding more sugar than milk naturally contains. In this way it was shown that when fermentable sugar is present in large quantities, the milk coagulates more rapidly with an increasing dilution.

With regard to the process of coagulation, it was found that when pure milk passed through a Chamberland filter is fermented, before an appreciable quantity of alcohol is formed, the liquid became cloudy from the appearance of a fine precipitate. This coagulation does not take place suddenly when unfiltered milk is used, but a deposit of casein which goes on increasing until the end of fermentation.

A similar condition of things is observed if the casein which has

* 'Der Einfluss d. Sauerstoffs auf d. Zerfall d. Eiweissstoffe in d. Pflanzen' (Russian), Warsaw, 8vo, 1889, 93 pp. See Bot. Centralbl., xxxix. (1889) p. 23; also Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 126–30.

† Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 258–60.

‡ Comptes Rendus, cviii. (1889) pp. 1067–9. Cf. this Journal, *ante*, p. 426.

been precipitated be redissolved in a saccharated solution passed through a Chamberland filter and fermented. Hence the action of the yeast upon the soluble casein, the casein in suspension, and the precipitated and redissolved casein, is the same.

γ. General.

Development of Annual Plants.*—In a further paper on this subject M. H. Jumelle states that when plants are grown in a medium deprived of salts, the absence of the salts not only causes a natural diminution of dry substance which is directly due to this absence, but the proportion of water in relation to the dry weight of the plant is also diminished. This results in certain anatomical and morphological modifications, which always accompany the diminution of the quantity of water in a plant. The large proportion of water in plants rich in salts is due to the slowness of the transpiration, and especially to the augmentation of the absorption. When a plant is provided with salts, but is grown in complete darkness, the absorption of mineral substances is excessively feeble, and takes place especially at the commencement of vegetation. The large proportion of water present which characterizes a plant grown in darkness is here also due to the slowness of the transpiration, and especially to the increase in the absorption.

Esparto-grass.†—Mr. J. Christie gives a careful description and drawing of the appearance presented under the Microscope of a transverse section of the leaf of the esparto-grass, *Macrochloa tenacissima*. On the upper surface of the leaf are a number of deep grooves or furrows, characteristic of grasses growing in very dry localities. These are clothed with unicellular hairs. Bands of fusiform cells, with strongly thickened and lignified walls, stretch from the upper to the lower epiderm, giving strength and rigidity to the leaf.

B. CRYPTOGAMIA.

Prof. de Bary's Microscopical Slides.—The collection of microscopical slides made by the late Prof. de Bary in the course of his work has been purchased by the Trustees of the British Museum. A few duplicate slides in use for teaching purposes had been acquired by the Botanical Institute in Strassburg University, and the slides of Bacteria have been kept by Dr. A. de Bary, of Frankfurt, in whose hands, as a skilful experimenter in this department of work, they will no doubt prove fruitful of results. The collection is therefore complete except the Bacteria, and the following statement of its contents may be of interest:—The slides of Fungi are 1220 in number, consisting of 283 Peronosporeæ, 59 Saprolegnieæ, 76 Mucorini, 54 Entomophthoreæ, 321 Ascomycetes, 217 Uredineæ, 10 Chytridieæ, 67 Ustilagineæ, 73 Hymenomycetes, and 60 Gastromycetes. Of other Cryptogams and Vascular Plants there are 1808 slides, representing Lichens, Characeæ, Algæ, Mosses, and Vascular Plants, making in all 3028 belonging to what may be called for Museum purposes the systematic series, though of course everybody knows the importance of these slides to the student of morphology. In addition there are 1112 slides illustrating anatomical

* Rev. Gén. de Bot. (Bonnier), i. (1889) pp. 359–89, 430–7 (2 pls. and 1 fig.). Cf. this Journal, *ante*, p. 668.

† Paper-trade Rev., xii. (1889) 2 pp. and 1 pl.

and histological subjects, and 289 slides which for convenience may be classed under Varia. This gives a full total of 4429 slides. Prof. de Bary's researches into the life-histories of Fungi, Conjugatæ, the anatomy of Vascular Plants, &c., are so well known to be of fundamental importance, that students of Botany in this country may be congratulated on having access to the authentic material used by the late distinguished botanist in his work.

Cryptogamia Vascularia.

Antherozoids of Vascular Cryptogams.*—From observations made chiefly on Ferns (*Pteris*, *Gymnogramme*, *Aneimia*) and Equisetaceæ, Herr W. Belajeff supports the conclusion previously arrived at by others, that in all Vascular Cryptogams the body of the antherozoid is an achromatic ribbon, in which a chromatin-filament or body is inclosed. The chromatin-body is in all cases derived from the nucleus of the mother-cell, the cilia and the so-called vesicle from the cell-protoplasm.

Sporocarp of Pilularia.†—M. Meunier has followed out in detail the development of the sporocarp of *Pilularia globulifera*, which he finds to agree with the account given by Goebel and Juranyi, except that he was unable to detect in the youngest conditions examined any connection with the leaf. Its vascular bundle appears, on the contrary, to spring directly from the cauline bundle. He agrees with Juranyi in regarding the sporocarp as corresponding to four divisions of the leaf, rather than with Goebel, who looks upon it as representing a single division only. He describes, moreover, the development of the peculiar refringent prismatic layer of cells beneath the epiderm of the sporocarp. The appearance is due to a continuous layer of albuminoid granules on the lateral walls of these cells, which become inclosed in the cell-wall when this increases in thickness. The development of the envelope of the spores out of the protoplasm which surrounds them differs in some respects from that described by Strasburger in the case of *Marsilia*.

Endoderm of the Stem of Selaginellaceæ.‡—In the stem of *Selaginella* no definite endoderm has at present been described. M. Leclerc du Sablon finds one in the species examined, *S. hortensis*, *inæqualifolia*, *caulescens*, and *triangularis*, but in a position different from that in which it is ordinarily found. The cells of the trabecules have a suberized framework, and this constitutes the endoderm; this framework is slightly thickened, but does not generally exhibit plication. The external layer of the central cylinder is the pericycle, in direct contact with the liber. The cells of the endoderm are therefore, in *Selaginella*, completely isolated from one another, and cannot perform their ordinary mechanical function.

Root of the Filicineæ.§—M. A. Trécul gives the following reasons in favour of his opinion on the radicular nature of the stolons of *Nephrolepis*, in reply to the views of Lachmann and Van Tieghem: ‖—(1) The different arrangement of the bundles in the mother-stem, and in the stolons; they are disposed round the pith in the stem, while they form a

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 122–5. Cf. this Journal, *ante*, p. 552.
† 'La Pilulaire,' Louvain, 83 pp. and 6 pls. See Bot. Ztg., xlvii. (1889) p. 592.
‡ Journ. de Bot. (Morot), iii. (1889) pp. 207–8 (1 fig.).
§ Comptes Rendus, cviii. (1889) pp. 1288–91. ‖ Cf. this Journal, 1885, p. 1033.

central group in the stolons; (2) the difference in structure of the bundles in the stem and in the stolons; (3) the absence of roots on the mother-stem, if the stolons are regarded as of a cauline nature; (4) the structure is always similar in the roots and in the stems of Ferns; (5) the roots of second and third order are monostelous, like the stolons.

Algæ.

Phyllactidium, Phycopeltis, and Hansgirgia.*—Dr. G. B. Toni assigns reasons for regarding *Phyllactidium arundinaceum* Mont. as a species of *Phycopeltis*, which must now be known as *Phycopeltis arundinacea*. He does not agree with Hansgirg in identifying *Hansgirgia flabelligera* with *Phycopeltis*. He affirms an important difference between the two genera, *Phycopeltis* being reproduced by non-sexual zoospores, *Hansgirgia* by sexual zoogametes, like *Trentepohlia*. *Mycoidea* he regards as occupying an intermediate position between the Coleochætaceæ and the Œdogoniaceæ.

Conjugation of Spirogyra.†—Mr. C. B. Atwell describes a case of conjugation in *Spirogyra longata*, in which, in two instances, the contents of a male cell have passed into two female cells, forming a zygosperm in each.

Volvox minor.‡—Prof. J. A. Ryder discusses the fore and aft poles, the axial differentiation, and a possible anterior sensory apparatus in *V. minor*. In every colony there was an empty pole, which was always anterior; the direction of the rotation of the colonies is not constant, and may be either sinistral or dextral; but the direction of progress always coincides with an imaginary axis passing through the centre of the anterior empty pole and the posterior germ-bearing portion of the nearly spherical colony. The diameter of a colony is slightly longer along the axis round which it revolves than in the direction transverse to it, so that the form of the whole is that of a very slightly oblong spheroid. The "eye-spots" found in the flagellate cells of the anterior pole of the colony were the largest, and as one passes in succession backwards the spots are seen to gradually diminish in size, until at last they are barely distinguishable. This arrangement revives the question as to whether these eye-spots are not really sensory organs. Prof. Ryder remarks that he has been unable to find any notice of any of the features of *Volvox* here described, and he expresses a hope that some microscopist will take up the study of *Volvox* anew, and publish a well-executed drawing of it.

Fungi.

Blastomyces.§—MM. J. Costantin and Rolland describe a new genus of Mucedineæ to which they have given the name *Blastomyces*. The following is the diagnosis:—A filamentous fungus forming at its extremity short branches which give rise both to the primary and secondary spores. Each fructifying branch is thus transformed into a pulverulent sporiferous mass. Aquatic and aerial chlamydospores on the mycele.

* Bot. Centralbl., xxxix. (1889) pp. 182–4. Cf. this Journal, *ante*, p. 419.
† Bot. Gazette, xiv. (1889) p. 154 (1 fig.).
‡ Ann. and Mag. Nat. Hist., iv. (1889) pp. 253–4.
§ Rev. Mycol., xi. (1889) p. 166.

One species only is known, to which the authors have given the name of *B. luteus.*

Synchytrium alpinum.*—Herr F. Thomas describes this new species of *Synchytrium*, parasitic on *Viola biflora*, on which it produces a large number of galls on all the parts of the plant above ground.

Ustilagineæ.†—Herr O. Brefeld has studied the development of about forty species of Ustilagineæ which he has induced to grow in artificial nutrient solutions. They exhibit various important differences. Conids were produced in great quantities,—in *Ustilago carbo*, *U. cruenta*, and *U. Maydis* beneath the fluid, in *Tilletia caries* in the air. In the latter species and its allies mould-like tufts were formed from the conids of the first culture; in the species of *Ustilago* named the conids formed on the short germinating filament of the ustilagospore multiplied rapidly by direct sprouting at the two ends. Other species, as *U. longissima*, *grandis*, and *bromivora*, formed conids on the bicellular myceles of the germinating ustilagospores, which did not sprout directly, but developed first into new promyceles, on which fresh production of conids took place. Other species again, as *U. Crameri* and *hypodytes*, formed no conids from ustilagospores which germinated in nutrient solutions, but only sterile germinating filaments which developed into sterile myceles.

In the case of *U. carbo* the sprout-conids are produced in an uninterrupted succession of generations as the only product in nutrient solutions outside the host-plant, while within it produces only ustilagospores. When the fluid is exhausted the conids put out germinating filaments. The power of the conids to produce ustilagospores, on which the infectious property of the fungus depends, was found to be weakened by time and by continued propagation outside the host-plant.

Ustilago carbo attacks the sheaths only of the oat, and only in a young state; and this parasite does not attack barley, the rust of this cereal being caused by a hitherto undescribed species *U. Hordei;* its spores germinated in nutrient solution without producing conids. On the other hand, all young parts of *Sorghum saccharatum* are attacked by *U. cruenta*. In the oat and millet the germs of the parasite (*U. carbo* and *cruenta* respectively) remain latent in the plant in the first stage of germination until the production of the sexual organs, when they develope in the young ovary and destroy the fructification. All parts of the maize are subject to the attacks of its parasite, *U. Maydis*, but the infection remains local.

Pathogenic Fungus from the Human Ear.‡—Dr. Lindt has cultivated from the human ear a fungus which belongs to the genus *Aspergillus*, and has the following characteristics:—Fine short septate mycele; very short conidiophores, with pyriform ends of 22–24 μ in diameter, and these bear colourless unbranched sterigmata arranged radiately. The chains of spores are slightly bent away from one another. The spores, which are small, have a faint green colour. The colour of the fungus is bluish-green. The peritheces are round, whitish, 40–60 μ large, and enveloped by a thick mycele. The wall consists of several layers of polyhedral cells. The asci are 14–18 μ

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 255–8.

† 'Neue Unters. üb. d. Brandpilze u. d. Brandkrankheiten,' Band ii., Berlin, 1888. See Bot. Centralbl., xxxix. (1889) p. 15.

‡ Arch. f. experiment. Pathologie u. Pharmakologie. xxv. (1889) p. 257.

large, biconvex to spherical, and contain eight sporids of 6–8 μ in size. The fungus developes best at the temperature of the body; the perithoces copiously on bread and potato in warmth. When introduced into the circulation of rabbits the spores killed the animals, which died in three to four days of a general mycosis.

Parasitism of the Truffle.*—M. H. Bonnet gives several instances in which truffles have been known to grow quite unconnected with the roots of any tree. They are generally found under the holm-oak, or chestnut, and in Europe, Africa, and the United States in the neighbourhood of all non-aquatic oaks. The author quotes M. Boudier's opinion on the parasitism of the truffle, which is that they must be rather considered as saprophytes than parasites, and that they live on the humus occurring in the neighbourhood of roots rather than on the roots themselves. As to the mycele, M. Condamy states that there is a female mycele, a white thread which produces the fruit, and a male mycele fixed on the roots, the concurrence of which is indispensable for the act of fecundation.

Fungi parasitic on Trees.†—Herr C. v. Tubeuf describes the fungi which cause a number of diseases on various trees in Germany. A prevalent disease of the Douglas-pine ‡ is caused by *Botrytis Douglasii* n. sp. *Trichosphæria parasitica*, hitherto known only on the spruce-fir, occurs also on *Picea excelsa*; and *Lophodermium brachysporum* must be added to the enemies of the Weymouth-pine. Two new species are described:—*Pestalozzia Hartigii*, parasitic on young plants of *Picea excelsa* and *Abies pectinata*; and *P. conorum Piceæ*, on fallen cones of *Picea excelsa*.

The author has observed the mycorhiza on the roots of *Pinus Cembra* at an altitude of 2200 m., in Tirol. It assumes two forms:—a coral-like form consisting of fine white and coarser brown filaments, with loop-cells, penetrating the bark as far as the endoderm; and fine filaments in the vessels of the swollen lateral roots which have been destroyed by the fungus.

Fungi parasitic on Rice.§—Herr F. v. Thümen enumerates thirty-four species of fungus parasitic on the rice-plant. Of these by far the most destructive is *Sphærella Malinveriana*, producing the disease known as "bianchella," "selone," "crollatura," "brusone," or "carolo," which annually destroys a large portion of the crop in Austria and Italy.

Echinobotryum and Stysanus. ‖—M. J. Costantin claims to have determined the identity of *Echinobotryum atrum* and *Stysanus Stemonitis*. This result he has obtained by the repeated careful culture of spores of *Echinobotryum*. At the end of the fifth day hemispherical tufts make their appearance, and these are shortly followed by a large number of conids, and then by the pseudo-capitula. By a series of insensible transitions the ramifications then appear, the pedicel elongates, and the transformation to the *Stysanus*-form takes place.

* Rev. Mycol., xi. (1889) pp. 124–7. Cf. this Journal, 1888, p. 780.

† 'Beitr. z. Kenntniss d. Baumkrankheiten,' Berlin, 1888, 61 pp. and 5 pls. See Bot. Centralbl., xxxix. (1889) p. 132.

‡ Cf. this Journal, 1888, p. 471.

§ 'Die Pilze d. Reispflanze,' 1889, 19 pp. See Bot. Centralbl., xxxix. (1889) p. 131.

‖ Journ. de Bot. (Morot), iii. (1889) pp. 240–3, 245–7 (1 pl.).

Dr. A. N. Berlese,* has come to the same conclusion, and regards *Echinobotryum atrum* as the secondary or chlamydosporal form of *Stysanus Stemonitis*. Of the four known species of *Echinobotryum*, *E. atrum*, *læve*, *Citri*, and *parasitans*, all but *E. læve* occur also in a Stilboid form, *E. Citri* as *Stysanus monilioides*, and *E. parasitans* as *S. caput-Medusæ*. *Stysanus* and *Pachynocybe* differ from one another in the spores being in chains in the former genus, solitary and acrogenous in the latter.

Prolification in the Hyphomycetes.†—Dr. A. N. Berlese states that it is not uncommon, in the hyphomycetous fungi, after the production of conids, for the conidiferous filament to renew its growth, and develope a second series of filaments. This appears to be a contrivance for maintaining the fungus in a latent condition until favourable conditions for germination occur. The phenomenon was observed in *Acrothecium atrum*, *Hormodendron cladosporioides*, *Botrytis vulgaris*, *Rhinotrichum* sp. and *Sporochisma mirabile*.

Laboulbeniaceæ.‡—Dr. A. N. Berlese gives a careful monograph of all the known species of this little-known order of Fungi, parasitic on insects and a few other animals, fifteen in number, mostly found in Austria, but some also in France, Russia, and America. They are characterized by having a perithece formed of a small number of cells, supported on a longer or shorter stalk, and provided laterally with filiform bodies varying in structure according to the genus. Within the perithece are fusiform hyaline sporids, septated in the middle and usually inclosed within asci. They are therefore abnormal Pyrenomycetes, and must be regarded as an appendix to that order.

A description follows of a new species, *Laboulbenia armillaris*, parasitic on *Antennophorus*, a genus of Acari, in Paraguay; and the following diagnoses are given of the order and of its six genera.

LABOULBENIACEÆ. Stipes plerumque inferne bicellularis, nodulose terminatus. Perithecium conicum, longe ovoideum vel subcylindraceum, sæpe inequilaterale, apice ostiolatum. Sporidia fusiformia, bicellularia, hyalina. Pseudoparaphyses filiformes, e latere perithecii orientes, simplices vel ramosæ.

Laboulbenia. Perithecium apice mammillatum, perforatum. Pseudoparaphyses simplices vel ramosæ, articulatæ, filiformes. 10 species.

Stigmatomyces. Perithecium in parte media incrassatum, in collum crassum tuberculo conoideo breviter bilobo terminatum desinens. Appendix lateralis perithecii, sive pseudoparaphysis, curvata, pluriarticulata, superne (hoc est in latere convexo) appendiculis acutis ornata. 1 species.

Helminthophana. Perithecium subcylindraceum, in collum cylindrium poro pertusum desinens. Ostiolum e corona cellulari multilobata formatum. Pseudoparaphysis ad basim stipitis inserta, subcylindrica, articulata, appendiculis acutis ornata. 1 species.

Appendiculina. Perithecium fere globosum, in collum prælongum fere cylindricum productum. Pseudoparaphysis basi perithecii inserta, articulata, appendiculigera. Ostiolum (saltem ex diagnosi et figura) simplex. 1 species.

Chitonomyces. Perithecium apice trilobum. Lobus medius apice

* Malpighia, iii. (1889) pp. 243–51 (1 pl.).

† T. c., pp. 251–9 (1 pl.).

‡ T. c., pp. 44–60 (1 pl.).

ruptus et sporidia emittens. Pseudoparaphysis lateralis, simplex, non articulata, curvata, nonnullis appendiculis tuberculiformibus prædita. 1 species.

Heimatomyces. Perithecium apice in cornu lateraliter pertusum productum. Pseudoparaphysis lateralis uniarticulata. 1 species.

Cotemporaneous action of different kinds of Saccharomyces.*—It has already been shown, says M. J. Vuylsteke, by Hansen, that in a mixture of low ferments and wild *Saccharomyces* the proportion of the cells of the latter was always greater at the end of fermentation than at the beginning. The comparison was made with the low yeasts Carlsberg i. and Carlsberg ii., with *S. Pastorianus* i. and iii., and *S. ellipsoideus* ii. The author's experiments were made with one high and two wild ferments, *S. cerevisiæ* i. and *S. Pastorianus* i. and iii. The results obtained by the author were as follows:—a greater infection at the end than at the beginning of fermentation was not always found with *S. cerevisiæ* i. and *S. Pastorianus* i., but the law laid down by Hansen for the low and wild species was found to hold good for *S. cerevisiæ* i. and *Pastorianus* iii.

The method adopted by the author in his experiments was to take vessels holding about two litres, and fill them two-thirds with hopped wort of a density of 14 per cent. Balling. These vessels and contents were then sterilized more or less, by heating them for two or three hours to 70°–90° C. From the scum obtained by inoculating with pure cultivations of the different yeasts, a certain quantity was pipetted off at the beginning of fermentation, and also at the end.

The proportion was calculated by two methods, the first of which was based on direct enumeration, and the second on the formation of ascospores. The second method is compulsory when a Burton or Carlsberg i. ferment is used, since these latter tend to assume the elongated form during the principal fermentation. In both cases the method given by Hansen was adopted.

Himalayan Uredineæ.†—Dr. A. Barclay describes sixteen species of Uredineæ from Simla (Western Himalaya). The following are new:—*Æcidium Saniculæ* on *Sanicula europæa* (probably connected genetically with *Puccinia Pimpinellæ*), *Puccinia Fragariæ* on *Fragaria vesca*, *Æcidium Jasmini* on *Jasminum humile*, *Monosporidium Euphorbiæ* gen. et sp. nov. on *Euphorbia cognata*, *M. Andrachnis* on *Andrachne cordifolia*. *Monosporidium* is characterized by the spores being abstricted in rows, but behaving in germination somewhat like teleutospores. The germ-tube produces at its extremity a secondary non-deciduous spore without the intervention of a sterigma.

Rostrupia, a new genus of Uredineæ.‡—Prof. G. v. Lagerheim identifies *Puccinia triarticulata* B. & C. with *P. Elymi* West., and establishes it as a type of a new genus of Uredineæ (*Rostrupia*) with the following diagnosis:—Sori uredosporiferi explanati, ureodosporis apice pedicelli solitariis; sori teleutosporiferi explanati; teleutosporæ simplices, 2-pluries septatæ (rarissime uniseptatæ), quoque loculo porum singulum germinationis gerente. Æcidia adhuc ignota, veresimiliter (ut in generibus *Uromyces* et *Puccinia*) pseudoperidio instructa et paraphysibus

* Ann. de Microgr., ii. (1889) pp. 190–218.
† Journ. Asiatic Soc. Bengal, lvi. (1887) pp. 350–75 (4 pls.).
‡ Journ. de Bot. (Morot), iii. (1889) pp. 185–9 (1 fig.).

destituta. Two species are described:—*R. Elymi* parasitic on *Elymus arenaria* and *E. mollis*, and *R. tomipara* (*Puccinia tomipara* Trel.) parasitic on a *Bromus*.

Subepidermal Rusts.*—Mr. H. L. Bolley states that he has been making a structural study of the teleutospore stage of *Puccinia coronata* and *P. rubigo-vera*, upon different hosts, with the hope of being able to obtain some differentiating structural characteristics. The results obtained, however, have been negative; for structural variations which were often quite marked upon some hosts were either absent from others or so slight as to be of no comparative value. In most species of Uredineæ, the teleutospores break through the epiderm of the host-plant; but in both the species mentioned they reach maturity in the matrix or sorus without rupturing the inclosing epiderm, a condition which is typical of a number of other species, and which, for the convenience of this paper, has been termed "subepidermal." These species present many common peculiarities of form and structure. In some cases, as *P. coronata* and *P. rubigo-vera*, species grade the one into the other so closely as to nearly defy separation upon a structural basis. The author also describes the various spore-forms to be found among the subepidermal rusts; and concludes by discussing in detail the development and structure of the stroma.

Cultures of Gymnosporangium.†—From the cultivation of various American species of *Gymnosporangium*, Mr. R. Thaxter has come to the conclusion that the true *Roestelia penicillata* is not at present known in that country; that *R. lacerata* is incorrectly named, and is the æcidium of *G. globosum*; and that *R. botryapites* is genetically connected with *G. biseptatum*, and *R. aurantiaca* with *G. clavipes*. *R. cornuta* is connected with either *G. globosum* or *G. conicum*.

Ravenelia.‡—Dr. D. D. Cunningham describes in detail the life-history of two species of *Ravenelia* common in the neighbourhood of Calcutta, *R. sessilis* and *R. stictica*. Each species produces two forms of uredospore and two forms of teleutospore, as well as "spermatia" contained in spermogones, but the æcidial generation is apparently entirely wanting. Otherwise they correspond to the normal type of Uredineæ.

Cæoma Smilacinis.§—Dr. A. Barclay describes a hitherto unknown species of *Cæoma* which attacks the leaves of *Smilax aspera* at Simla (N.W. Himalayas). He believes it to be the first completely autœcious species of *Cæoma* yet described, the uredo-form and æcidio-form being parasitic on the same plant. The æcidial form begins to appear in June or July, and the leaves which bear it drop off in October or November. In October the uredospore-form begins to appear in distinct patches on the same leaves. The formation of teleutospores commences in November.

Macrosporium parasiticum.‖—Mr. A. E. Shipley describes the life-history of this fungus, found abundantly on diseased onions in the

* Bot. Gazette, xiv. (1889) pp. 139-44 (1 pl.).
† T. c., pp. 163-72. Cf. this Journal, 1887, p. 445.
‡ Scient. Mem. by Medical Officers of the Army of India, 1889, 15 pp. and 2 pls. Cf. this Journal, 1887, p. 446.
§ Scient. Mem. by Medical Officers of the Army of India, 1889, 9 pp. and 2 pls
‖ Ann. of Bot., iii. (1889) pp. 268-71. Cf. this Journal, *ante*, p. 562.

Bermudas. He shows, however, that the very destructive disease to which the crop is subject in those islands is due to the attacks of the white mildew, *Peronospora Schleideniana*; the black mildew, or *Macrosporium parasiticum*, appearing only on plants already enfeebled by disease.

Peach-Yellow.*—Mr. E. F. Smith gives a preliminary report on a disease which affects peach-trees in the United States. It is not certain whether peach-yellow is due to a fungus or to bacteria, but the author gives a list of the fungi which attack peach-trees. *Taphrina deformans* Tul. is found on the leaves; *Sphærotheca pannosa* Lev. also attacks the leaves; while *Puccinia Pruni spinosæ* P. brings about their premature fall; *Oidium fructigenum* Kze. et Sch. attacks the fruit; *Cladosporium carpophyllum* Thüm. developes on the surface of the leaves and fruit; *Ascospora Persicæ* Sacc. is found on the lower surface of the leaves; and finally *Capnodium elongatum* Bk. et Desm. and *Polyporus versicolor* Fr. are also found on the peach.

Boletopsis, a new Genus of Hymenomycetes.†—M. V. Fayod separates from the genus *Polyporus P. melaleucus* Pers., in consequence of the character of the spores, which, instead of being white and ovoid, are angular, and when seen in quantities, flesh-coloured. The following is his diagnosis of the new genus:—

Boletopsis. Thallus carnoso-lentus subnudus (cuticula pilei adumbrata), pileo (semper) centraliter stipitato, strato tubulifero tenui, carneo, inseparabili. Poris albis, minutis, dein laceratis. Trama homomorpha, densa, e hyphis tenuibus plus minusve dispersis, subhymenio carens. Basidia 2–4 stigmatica, parvula. Sporæ gibbosæ-angulosæ, carneæ.

Dispersion of the Spores of Fungi by Insects.‡—Dr. T. W. Fulton describes the rapid growth, immediately before maturity, of the hymenophore of *Phallus impudicus*, and the mode in which it deliquesces when the spores are ripe. The fœtid fluid thus formed is exceedingly attractive to flies, which carry away enormous numbers of spores, both attached to and within their bodies. It was ascertained by experiment that passage through the body of a fly does not destroy the vitality of the spores.

Other contrivances for attracting flies for a similar purpose, such as a flower-like form or bright colour of the receptacle, are, according to the author, manifested by others of the Phalloideæ and by species of *Coprinus*.

Mycetozoa.

Colouring-matters of Mycetozoa.§—Prof. W. Zopf gives an account of the lipochromes or fatty pigments found in various species of Mycetozoa, especially in the following:—*Stemonitis ferruginea*, *S. fusca*, *Lycogala epidendron*, *L. flavo-fuscum*. The more important general results of the investigation are stated to be that the pigment in all these four species belongs to the yellow series. The spectrum of the pure lipochrome of *Lycogala* shows several peculiarities. Besides the two well-known absorption-bands, one in F, the other between F and G,

* 'Peach-yellow,' Washington, 1888. See Rev. Mycol., xi. (1889) pp. 160–3.
† Malpighia, iii. (1889) pp. 69–73 (3 figs.).
‡ Ann. of Bot., iii. (1889) pp. 207–37 (1 pl.).
§ Flora, lxxii. (1889) pp. 353–61 (1 fig.). Cf. this Journal, *ante*, p. 560.

belonging to all yellow fatty pigments, there are two additional ones, one at G, the other between E and *b*. In addition to the lipochrome, there was found, in each of the four species examined, an amorphous pigment soluble in water, and of an acid character.

Protophyta.

α. Schizophyceæ.

Growth of the Cell-wall by Intussusception in some Schizophyceæ.*—Herr C. Correns states that in *Glœocapsa* and *Petalonema* certain definite layers of the cell-wall increase in volume, although separated by similar layers from the protoplasm of the cell. Since this is not accompanied by swelling, it can only be brought about by the intercalation of water and particles of substance between those already in existence. The proofs that the increase in size is not the result of swelling are given in detail.

In *Petalonema* it is not the apical cell alone, but all its segments to a certain distance from the apex that divide. The gelatinous sheaths are formed from the apex, and are usually of a funnel-shape, and probably formed by apposition. The entire sheath is inclosed in a pellicle, which, through growth by intussusception, keeps pace in volume with the sheath, and is not burst or broken through by the growth of the funnels. The sheath, and especially the junction of the inner and outer sheath, is coloured yellow or brown-yellow by scytonemin. The presence of the pellicle and the thickness of the sheath distinguish *Petalonema* from *Scytonema*.

Prasiola.†—Herr L. Imhäuser separates *Prasiola* from the Ulvaceæ, and erects it, possibly along with *Protoderma* and *Schizomeris*, into a distinct family of PRASIOLACEÆ, nearly allied to Palmellaceæ. All the species consist, when mature, of a larger or smaller plate of cells; and are distinguished from the Ulvaceæ by the mode of reproduction, which is a purely non-sexual one, and takes place by the plate breaking up into larger or smaller areolæ, or more usually into single cells; less often filaments of cells are split off. From the isolated cell is always developed a filament, which then grows into a plate. *Hormidium* and *Schizogonium* are merely stages in the development of these plates. The following six species are described, the first alone being free, all the rest attached:—*P. crispa*, *furfuracea*, *stipitata*, *Sauteri*, *calophylla*, and *mexicana*.

Heterocystous Nostocaceæ.‡—Supplementing Bornet and Flahault's monograph of the heterocystous Nostocaceæ contained in the herbaria of France, M. E. Bornet now describes the specimens contained in the herbarium of Agardh, many of which are the type-specimens of the *Systema Algarum*.

Movements of Diatoms.§—From observations made on various species of *Navicula*, especially of the sub-genus *Pinnularia*, Herr O. Müller confirms his previous hypothesis that the movements of these diatoms are connected with perforations in the cell-wall. He finds that immer-

* Flora, lxxii. (1889) pp. 298-347 (1 pl.). † T. c., pp. 233-90 (4 pls.).
‡ Bull. Soc. Bot. France, xxxvi. (1889) pp. 144-57. Cf. this Journal, 1888, p. 472.
§ Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 169-80 (1 pl.).

sion in a weak solution of sodium chloride causes immediate suspension of the movement, which commences again on immersion in pure water; from which he concludes that it is not the result of osmotic processes. The interior protoplasm appears to have a tension of 4–5 atmospheres, which would cause it to rush out through the openings in the valve, if the channels which lead to these openings were not of a winding and complicated character. He believes rather that the movement itself and the direction of this movement are the result of motor forces which are manifested on the surface, residing in the protoplasm which is protruded through the raphe.

Auxospore of Terpsinoë.*—Herr O. Müller describes the auxospore of *Terpsinoë musica* from St. Domingo. The length of the valve of the auxospore varies between 223 and 257 μ, while that of the mother-cell is only from 92 to 106 μ. The formation takes place on the same general plan as that of *Melosira*, and is a process of simple rejuvenescence rather than of sexual reproduction. The mass of protoplasm which expands and projects between the valves of the mother-cell fills up the older half of this cell, withdrawing itself entirely from the younger half; the perizone surrounding the portion of the protoplast which adheres to the older half. The new girdle is formed in the portion of the protoplasm surrounded by the perizone which faces the younger half, and this is followed by the excretion of the second auxospore-valve. In the genus *Terpsinoe* the cavity of the valves is divided by septa, the purpose of which is to bring the chromatophores into a profile-position under the powerful tropical insolation.

Diatom-beds of the Yellowstone.†—Mr. W. H. Weed describes the composition of the enormous diatom-marshes and diatom-beds of the Yellowstone National Park, U.S. He finds them to consist mainly of the following species:—*Denticula valida* and *elegans*, *Navicula major* and *viridis*, *Epithemia argus* and var. *amphicephala* and *E. Hyndmannii*, *Cocconema cymbiforme*, *Achnanthes gibberula*, *Mastigloia Smithii*, and *Fragillaria* sp., of which the first is the most abundant.

β. Schizomycetes.

Micro-organisms and their Destruction.‡—Dr. A. B. Griffiths, who has continued his researches on micro-organisms, thinks that as the microbes, which are the real cause of certain contagious diseases, may be destroyed by various germicides, we ought, by further investigation, to discover remedies for such scourges as consumption and syphilis. The author finds that the vitality of *Bacillus tuberculosis* is considerable, and that it is capable of being dried up in the atmosphere for many weeks without its vitality being impaired. The electric current destroys the vitality of certain microbes. Dr. Griffiths has discovered that a new microbe, which he calls *Bacterium allium*, is the cause of putrefaction in the onion, and that it liberates small quantities of sulphuretted hydrogen. The soluble zymoses secreted by living microbes are capable of being destroyed by germicidal agents, and are thus rendered incapable of producing chemico-pathological changes in the blood-tissues.

* Ber. Deutsch. Bot. Gesell., vii. (1889) pp. 181–3 (1 pl.).
† Bot. Gazette, xiv. (1889) pp. 117–20.
‡ Proc. R. Soc. Edinb., xv. (1888–9) pp. 33–65.

Micro-organism found in the mucous flux of Trees.*—In 1886 Prof. Ludwig described an alcoholic fermentation and mucilage which he had observed in certain trees, and expressed the opinion that the fermentation was due to a fungus which he called *Endomyces Magnusii.* Besides this, two other Saccharomycetes and a new Schizomycete, *Leuconostoc Lagerheimii*, were noted. From further observations, published in 1888, Prof. Ludwig concluded that the mucilage was due to Bacteria.

Dr. E. C. Hansen now describes the mucilage which he has observed in seventeen cases, and in only one of these was the *Endomyces Magnusii* found; hence this author points out that it cannot be considered the cause of the flux. Owing to the number of different animal and vegetable parasites in these seventeen cases, Hansen concludes that it would not be safe to infer that any one was the specific cause of the mucilage, but is of opinion that, considering the cause of "pear-blight" has been shown to be a bacterium, the *Micrococcus amylovorus*, it is probable that a bacterium should be sought for as the cause.

He then goes on to discuss one of the Saccharomycetes found by Ludwig in the scum on the trees. The latter considered this *Saccharomyces* to be a developmental stage of *Endomyces* and its *Oidium.* The question Hansen resolves into:—Can the *Oidium*-form be made to develope into the *Endomyces*-form? can the *Saccharomyces* be developed from the *Oidium*, and conversely, if starting from the *Saccharomyces*, can the *Oidium* and *Endomyces* be obtained? These questions are answered in the negative.

Still more recently, Prof. F. Ludwig † has made further contributions to the pathogenesis of this disorder, and he states that the mucous flux is produced by the symbiotic schizomycete, *Leuconostoc Lagerheimii.*

Considering, however, the number of micro-organisms and their great differences, the question would not appear to be at present answered satisfactorily.

Pleomorphism of Bacteria.‡—M. Metschnikoff replies in an article on the pleomorphism of Bacteria to the theories enunciated by Winogradsky.

Spirobacillus Cienkowski, which was made the subject of examination, justifies its name, as it passes successively through the stages of *Bacterium*, *Bacillus*, and *Spirillum.* This parasite attacks the small aquatic crustacean *Daphnia*, and imparts to it its red colour.

The author was able to follow the transformation of the Bacteria through the different phases of the disease: the stages figured seem to form the transition between the most distant forms. The author's results were, however, not obtained by cultivations, consequently they are not altogether convincing.

Movements of Micrococci.§—It is usually accepted, says Dr. C. H. Ali-Cohen, that micrococci are not endowed with any characteristic movements. There are, however, no *a priori* considerations why this kind of Bacteria should differ from other kinds; that is, why a spheroidal microbe should be incapable of motion, while an oval or rod-like one should be gifted with specific movements.

* Centralbl. f. Bakteriol. u. Parasitenk., v. (1889) pp. 632–40, 663–67, 693–6. Cf. this Journal, 1887. p. 285.
† T. c., vi. (1889) pp. 133–7, 162–5.
‡ Ann. Inst. Pasteur, 1889. Cf Bull. Soc. Bot. France, xxxvi. (1889) p. 51.
§ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 33–6.

The author has been able to breed from drinking-water cocci which are possessed of a high degree of movement. Though almost always diplococci, they sometimes appear as streptococci, and betimes as tetrads; their diameter is 1 μ. The double cocci are clearly divided by a fissure, and, both in the unstained and in preparations stained with fuchsin or by Gram's method, their coccus form is indisputable. Their form is easily cultivated at the ordinary temperature in gelatin-agar, potato-paste, &c., but does not grow at the body temperature. They liquefy gelatin, but only very slowly. Though the cocci themselves seem to be colourless, they always produce a rose-coloured pigment. The peculiar motion with which they are endowed is easily observed in drop-cultivations. This is best seen in 5 per cent. milk-sugar-agar, wherein it is kept up for several days.

The movements are swimming in character, various in direction, and of a rapidity of about 10 μ a second. Anything which lessens the vitality of the cocci diminishes the movements, and they cease altogether in 1 per 1000 $HgCl_2$, 5 per cent. carbolic acid, dilute sulphuric acid, or if killed by heat, though the molecular movements still go on.

These two kinds of movements can be differentiated by increasing the viscosity of the fluid; for, as this is increased, so the molecular movements diminish. Again, the more the drops are cooled down, the more the viscosity increases, until finally the Brownian movements cease altogether. At this point the specific movements are still going on, and only cease when the drop has become solid.

To this fungus the author gives the name of *Micrococcus agilis.*

Variability of Bacillus anthracis.*—M. A. Chauveau has continued his important investigations into the conversion of pathogenetic microbes. He finds that by continuing the action of compressed oxygen on cultivations of developing *Bacillus anthracis*, he is able to form races or types, which offer less resistance than the primitive *Bacillus*, and are particularly sensitive to the action of the attenuating agent to which the *Bacillus* owes its new properties. If the influence of the attenuating agent is continued, the new types finally lose their power of growing when brought into contact with it; but so long as the *Bacillus* does not pass the limits of vegetability, it remains among pathogenetic agents. It is true that it loses all its virulent properties, but it completely preserves the vaccinal property, and preserves it almost intact during the whole period of its existence. These new characters are definite, and may be easily brought about by cultivation in successive generations. If we were to take no account of their origin, we might regard these types by themselves as forming distinct species. It is not impossible that special types of *Bacillus anthracis* do exist in nature with properties absolutely identical with those of the races which have been made in the laboratory.

New Bovine Tubercle Bacillus.†—M. J. Courmont has found a new tubercle bacillus in the pleura of an ox attacked with "pommelière."

The bacillus is short and broad, and consists of a clear median zone, slightly constricted, and of two terminal nuclei (? spores). It is very mobile, grows rapidly on all the media usually employed, and does not liquefy gelatin. Cultivations were obtained at 46°, and in vacuo. It is easily stained and decolorized. The tubercles of the ox, when not mixed with the bacillus of Koch, gave pure cultivations straight away.

* Comptes Rendus, cix. (1889) pp. 554-9. † T. c., pp. 160-2.

Rabbits inoculated with juice from the tubercles became tuberculous in fifteen to twenty-four days; while guinea-pigs died in the first ten days, presenting simply a local œdema and swelling of the spleen. The tubercles from the rabbits gave pure cultivations of this bacillus, never that of Koch; but the blood of both rabbits and guinea-pigs swarmed with the microbe.

A particular point in the history of this new bacillus relates to the action of the secretions produced in the organism. Far from vaccinating the inoculated animal, these secretions prepare the soil for the multiplication of the microbe.

Relation of the Bacilli of the Aleppo Pine to the living tissues.*— M. P. Vuillemin, who had previously demonstrated that the excrescences on the Aleppo pine were due to the penetration of a bacillus into the cambium, has now shown the way in which the microbes arrive there, and what relations they contract with the living elements. On the diseased branches are seen crateriform projections about the size of pins' heads. In the centre of these bosses is a canal, which would seem to have been made by the proboscis of some insect. The tissue of the boss, that which bounds the central canal, is practically cicatricial, and when attacked by the bacillus, the regularity of the healing process is interrupted. It would appear that the bacilli gain entrance through the canal, although in the youngest wounds the zooglœa are not in immediate contact with the crater. They are, however, close to it, and seem to occupy exclusively the intercellular spaces; and in their immediate neighbourhood there is evidence always of considerable inflammation. Owing to the manner in which the cicatrization tends to impede the progress of the development of the bacillus, three varieties of tumour are distinguished: tumours originating from the cambium and from the cortex, and those of a mixed type. In every case the bacilli remain confined between the cells as long as these are alive. Hence it is through the cellulose wall that specific action is exerted, and the history of this disease affords support to the doctrine which attributes a toxic influence to the fluids excreted by pathogenic bacteria.

Cholera Bacillus.†—Dr. D. D. Cunningham has made a series of experiments with the cholera bacillus, in order to determine if the microbe be the efficient cause of epidemic cholera.

The experiments indicate that when introduced into soil and water of very different qualities, the comma bacilli tend to disappear very rapidly.

The author then proceeds to discuss the theories of Koch and Hueppe, and finally concludes that, "view the question as we may, the paramount importance of local conditions, and the subordinate and secondary role which the comma bacilli must play in reference to epidemic diffusion of cholera, is very evident."

Preventive Inoculations.‡—We can only call attention to Dr. E. Roux's "Croonian Lecture," which may be recommended as giving a general conspectus of the theorics and mode of work of M. Pasteur.

* Comptes Rendus, cvii. (1888) pp. 1184–6.
† Scient. Mem. by Medical Officers of the Army of India, 1889, 20 pp.
‡ Proc. Roy. Soc., xlvi. (1889) pp. 154–72.

Antagonism of the Bacillus of Blue Pus and Anthrax.*—Dr. E. de Freudenreich confirms in the main the results of Prof. Bouchard on the antagonism between the bacilli of blue pus and anthrax. The experiments of the latter gave a resistance of 46 per cent., but the author's percentage falls to 28. The greater the amount of the blue pus virus injected, the greater the immunity. On the other hand, it was found that if the quantity injected was small, the anthrax pursued its fatal course unchecked. It is suggested, basing the supposition on the doctrine of phagocytes, that the cells had not been sufficiently stimulated by the blue pus, and hence were not fully awakened to their responsibilities.

* Ann. de Microgr., ii. (1889) pp. 465–9.

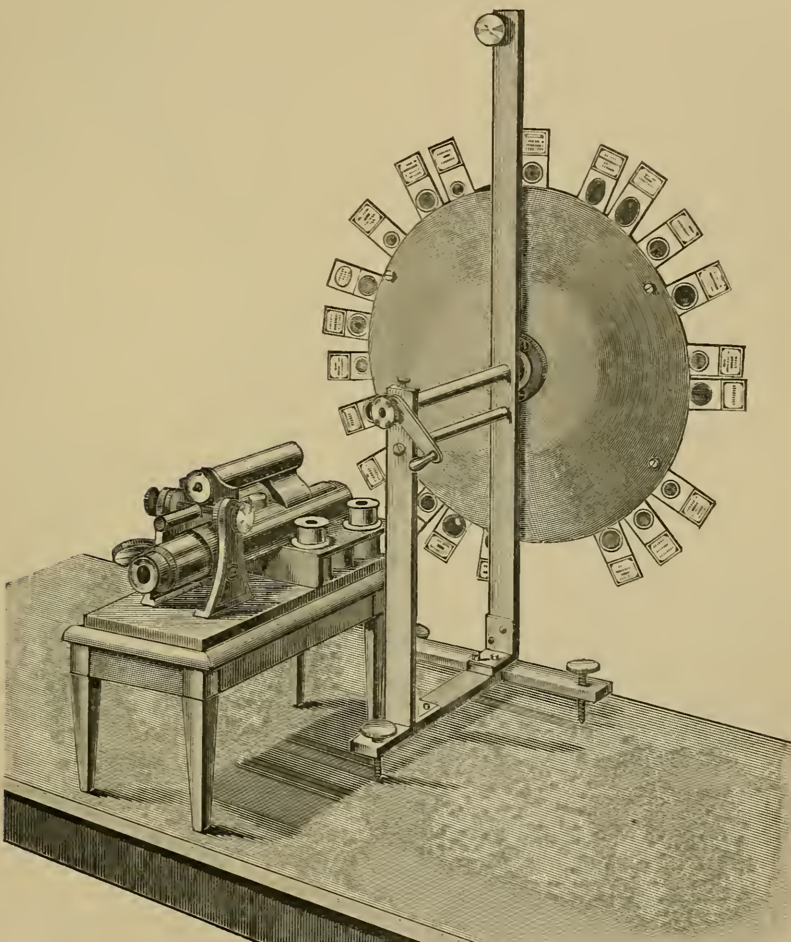
MICROSCOPY.

a. Instruments, Accessories, &c.*

(1) Stands.

Anderson's "Panoramic Arrangement for the Microscope."†—Prof. R. J. Anderson's apparatus (fig. 97) "consists of a circular disc,

Fig. 97.



which is made to revolve by means of a handle. The disc is fixed to one extremity of an axle, and the handle to the other. The axle has a

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

† Internat. Monatschr. Anat. u. Physiol., vi. (1889) 2 pp. and 1 pl.

telescopic arrangement by which the disc is approximated to the handle or removed farther from it. The disc is brought near to the handle by means of a screw-nut fixed at the end of the inner part of the axle, and it is moved away by means of a concealed spring. The amount of this motion is not more than three millimetres. The disc and axle are fitted on a strong iron stand, supplied with levelling screws.

The frame is so arranged that the disc may be used in the vertical or in the horizontal position. The vertical position is, perhaps, the most convenient for museum demonstration. The apparatus, when used in this position for museum demonstration, is placed in a closed case. The handle, with its binding screw and focusing button, are the only parts of the apparatus outside the case.

The disc is furnished with slides. These are clipped to the face of the disc by means of a segmented ring. The upper surface of each specimen is turned towards the observer, so that the thickness of the slide is not involved in the focusing adjustments. The disc must be so placed that it will be perfectly parallel to the front of the case, and the light must fall on the face of the disc. The former condition is secured by means of the levelling screws and a square, and the latter by having the case in front of a window.

The Microscope is fitted to a brass plate which slides in a second plate fixed to the front of the case on the same level as the axle of the apparatus, and at a distance equal to the semi-diameter of the disc. A lateral motion of the Microscope is best caused by a wheel and rachet arrangement. The possible movement is one inch.

The Microscope, then, being fixed for any specimen, it is evident that the screw button on the axis serves to focus the specimen, and is similar to a fine-adjustment. Secondly, a specimen may be examined from side to side by means of the lateral motion of the Microscope. Thirdly, the specimen may be swept from above down by the handle moving the disc; and lastly, a whole series may be examined one after another. It is quite safe to place the instrument in a museum case. No one can injure the slides or spoil the Microscope, as the limits of motion are fixed, and the student can thus study a series of specimens without supervision.

The instrument may be used in the same position for class demonstration, or it may be turned, levelled, and thus used in the horizontal position by means of an ordinary arrangement for reflected light.

The Microscope tube is, under ordinary circumstances, so close to the vertical portion of the stand, that a special stand is necessary for use in the horizontal position.

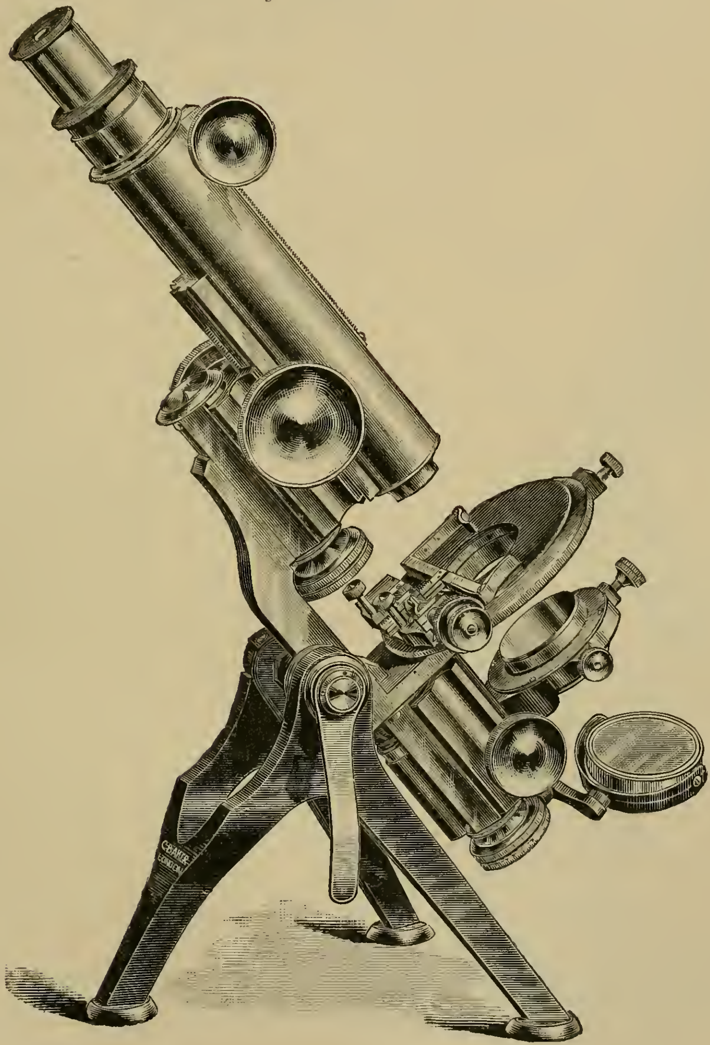
The museum case should be provided with curtains, as some preserved specimens are injured by the light and heat."

Nelson-Curties Microscope (Large Model).— This Microscope (fig. 98) is the joint production of Mr. E. M. Nelson and Mr. C. L. Curties.* It stands on a firm tripod foot, the extremities of which are plugged with cork, diminishing vibration and preventing it slipping or injuring a table. Depending from the trunnions is a kind of stirrup, to which the Microscope is attached. This stirrup lowers the centre of gravity when the Microscope is vertical or in an inclined position, and gives a better balance when the instrument is horizontal for photo-

* See this Journal, 1888, p. 691.

micrography or other purposes. The body can be clamped by means of a lever attached to one of the trunnions. The body is specially constructed to work with Abbe-Zeiss apochromatic objectives, and is fitted with a rackwork draw-tube for lens adjustment; it will rack out sufficiently to adjust these lenses on the thinnest covers.

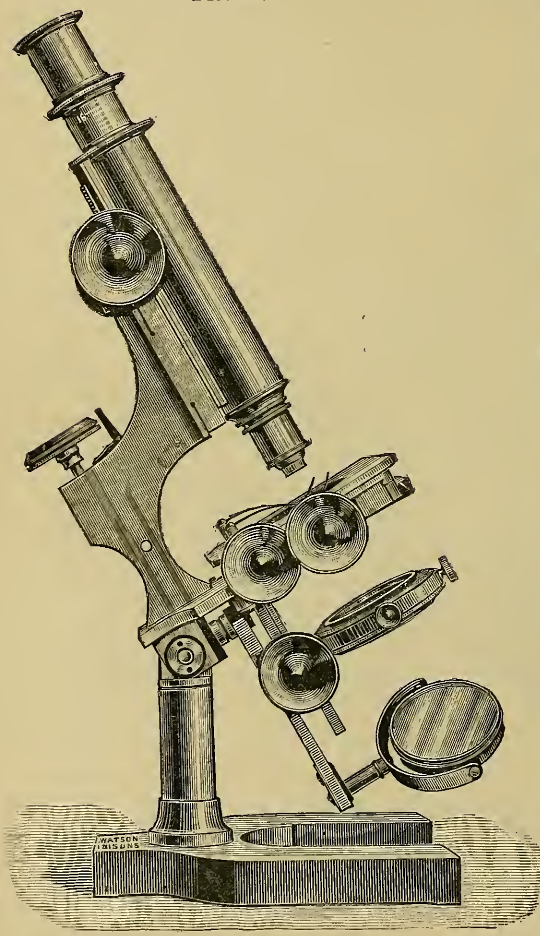
Fig. 98.



There is the usual rackwork coarse-adjustment. The fine-adjustment is a Campbell differential screw. This fine-adjustment, while being very strong, works with great smoothness and delicacy. It is claimed that the differential screw solves the difficulty which has always existed with direct-acting screw fine-adjustments, viz. that of providing a slow movement by means of coarse strong threads; in all other direct-acting screw fine adjustments, if they are slow enough to work wide-angled oil-immersion objectives, the movement is obtained by means of a micrometer-screw with a very fine thread, which is too weak to stand the usual wear and tear. The milled head of the fine-adjustment is placed below the limb. In this new position it is found to be quite convenient for ordinary work, while it is steadier when a cord is attached for photomicrography.

The stage is plain rotary, having Mayall's mechanical movement attached; it can be clamped by the screw in front. The substage has centering movements, rack-and-pinion coarse - adjustment, and differential - screw fine-adjustment, admitting of wide - angled condensers being easily focused. The usual plane and concave mirrors on a double-jointed arm are carried on an adjustable hinged tail-piece.

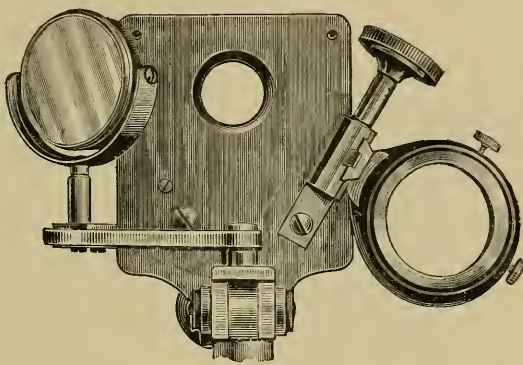
Fig. 99.



Edinburgh Student's Microscope.—This Microscope (figs. 99 and 100) has been made by Messrs. W. Watson and Sons, on lines suggested by Dr. Edington, Lecturer on Bacteriology at Edinburgh University. Fig. 99 shows the instrument in its simplest form, with sliding body for coarse-adjustment, Continental horse-shoe foot, and body - tube of the Continental size, fitted with draw-tube, which, when extended, gives the full English length of 10 in. The fine-adjustment—a part often neglected in instruments of Continental make—is worked by the rotation of a milled head acting on a lever moving the entire body. A tenth of a turn of the milled head only moves the body 1/3000 in., so that a precise adjustment can be made.

Another point is the hanging of the under-stage, fitted on a pivot so that it can be lifted aside with a condenser in it, and direct light from the mirror obtained at once. Fig. 100 is view of the under side, and shows the way in which it is done. This is a distinct advantage, and workers with the ordinary form of instrument, in which the con-

FIG. 100.



denser must be withdrawn if direct light from the mirror is required, will at once appreciate it. The stage of the instrument is $3\frac{1}{2}$ in. square, permitting of the use of large slips. The eye-pieces supplied with the instrument are nickel-plated.

Leach's Improved Lantern Microscope.—The principle upon which this Microscope (figs. 101–103) is constructed, was briefly described in a paper which Mr. W. Leach read before the Manchester Microscopical Society in 1887, an abstract of which appeared in this Journal.* There was no thought when this paper was read of placing the Microscope in the market; but the great amount of private correspondence which followed its publication, led to the instrument being manufactured for sale.

The stage used in it was an old and well-known form; but it failed to give satisfaction on account of the obstacles which the object-holder, with its four arms and the springs coiled round, offered both to the changing of the sub-condensers through the stage, and to the attachment of a rotating tube for polarizing prism. To get rid of these obstacles a new arrangement of object-holder has been devised and placed underneath the stage, the arms passing through slots in the bottom, so as to hold the objects against the inside surface of the front of the stage. The new object-holder is thus placed out of the way of all the mechanism and all the material used in the stage. In changing the sub-condensers, all which it is now necessary to do is to take out the one in use and substitute the other, neither object, objective, nor wheel of diaphragms being disturbed in doing so.

The compound wheel of diaphragms is peculiar in its construction. One part of it has a large single aperture, and moves by means of an arm upon a pivot, so that it can be lifted up out of the field or dropped into it, just as it is or is not wanted. A spring catch holds it up in its place, so that it cannot fall by its own weight. To the armed wheel is attached a second wheel with five concentric apertures, any of which can

* See this Journal, 1887, p. 1019.

be turned into the centre of the field at pleasure. When the compound wheel is lifted up as shown in fig. 103, the whole field of the Microscope can be utilized for showing objects up to $1\frac{1}{2}$ in. diameter. Thus the compound wheel, $2\frac{1}{2}$ in. diameter, yields just as large a field as can be obtained by one of the ordinary form when 5 in. diameter.

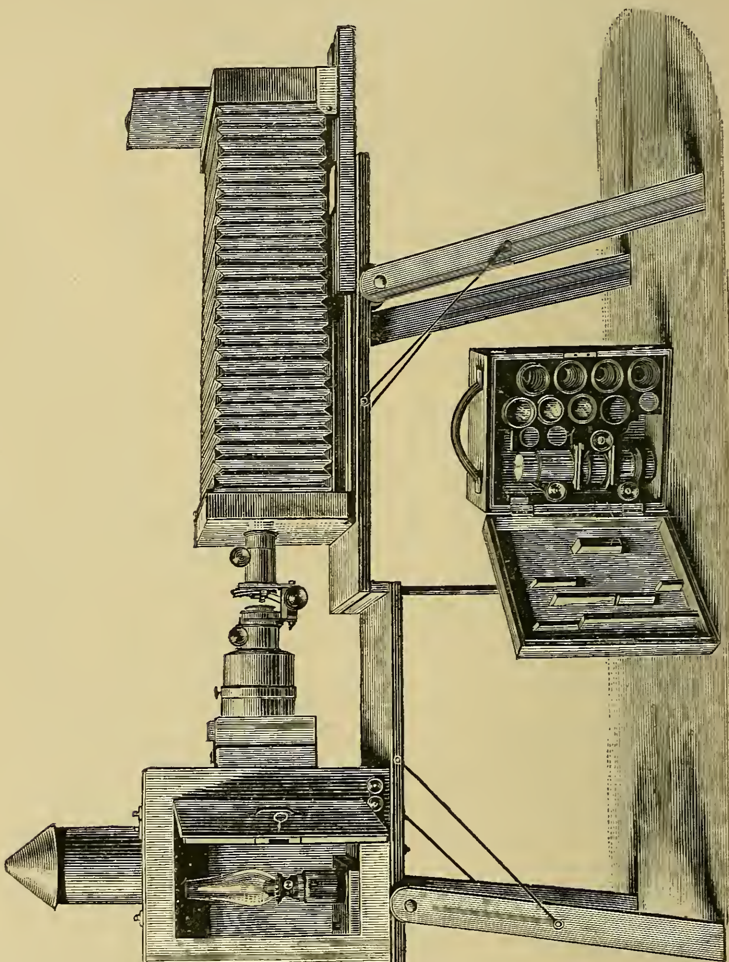


Fig. 101.

When, as in using polarized light, it is not desired to be incommoded with the wheel of diaphragms, the detachable plate carrying the compound wheel can be instantly taken out of the stage, and when taken out can be as quickly put in again. It should be noted that one stage serves for all classes of objects, whether ordinary slides or polariscope crystals shown with narrow-angle rays or the convergent system of lenses. The tube for the polarizing prism is fitted for entire rotation, and all the phenomena of polarized light can be demonstrated by the instrument. It is also equally useful for photomicrography, as the optical principle is based upon the system introduced by the late Rev. T. W. Kingsley, but greatly improved in both optical and mechanical effects.

Fig. 101 will give an idea of the way in which the arrangement is made, a paraffin lamp with 1/2 in. wick being the source of illumination

Fig. 102.

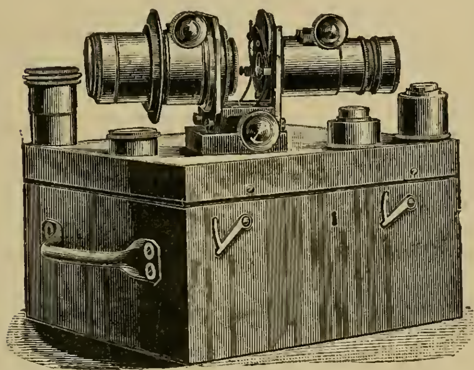
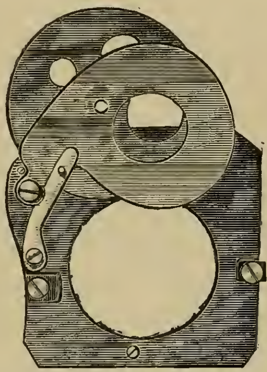


Fig. 103.



for this purpose. "The instrument having been constructed by a working man (an operative photographer) who has devoted to it all his leisure hours for a period of over ten years, it has been deemed only fair that he should seek some remuneration for his labour, and he has therefore secured his improvements to himself by a patent." *

"AMATEUR."—**Notes on the Microscope Stand and some of its Accessories. III.** *The Microscope*, IX. (1889) pp. 330–6.

CRISP, F.—**Ancient Microscopes.** *Proc. Royal Institution*, XII. (1889) p. 201.

Seibert's Microscope.

["By means of an improved Microscope made by Seibert of Wetzlar the internal structure of the anthrax bacillus can be made out. This consists of a series of pearl-like corpuscles, which can be plainly seen to undergo division. The magnifying power of the Microscope is said to be 2250 diameters."] *Lancet*, II. (1889) p. 887.

(2) Eye-pieces and Objectives.

1/10 in. Apochromatic Objective of N.A. 1·63.—Prof. Abbe has designed, and Dr. Zeiss has produced a 1/10 in. apochromatic objective of the large numerical aperture of 1·63, the limit hitherto reached having been N.A. 1·50 in the case of an objective made by Mr. T. Powell. Monobromide of naphthaline is used as the immersion fluid, and the slides and cover-glass are made of flint glass.

An immersion condenser of N.A. 1·60 has also been constructed by Dr. Zeiss in order to secure approximately the full aperture of the objective.

Dr. H. van Heurck reports † that the objective allows of the resolution of all known tests by axial illumination, and shows new details in certain Bacteria.

* Cf. Eng. Mech., l. (1889) pp. 242–3 (3 figs.).
† Bull. Soc. Belg. Micr., xv. (1889) pp. 69–71.

Dr. J. Pelletan refers* to the price of the objective as being 10,000 francs, or 400*l.*, but we have no verification of this statement.

Apochromatic Objective stolen. ["From the K. mechanisch-technischen Versuchs-Anstalt in Berlin-Charlottenburg has been lately stolen an apochromatic objective of Carl Zeiss of Jena, homogeneous immersion, numerical aperture 1·30, focal length 2 mm. Besides the name of the firm and the usual data, the objective has the maker's number 555 engraved in small figures. It is requested that the objective may be retained should it be offered for sale."]

Central.-Ztg. f. Optik u. Mechanik, X. (1889) p. 143.

HEURCK, H. VAN—**La nouvelle combinaison optique de Zeiss et les perles de l'Amphipleura.** (The new optical combination of Zeiss, and the beads of *Amphipleura.*) *Bull. Soc. Belg. Micr.*, XV. (1889) pp. 69–71.

(5) Microscopical Optics and Manipulation.

Diffraction Theory.—Prof. B. T. Lowne and Mr. E. M. Nelson have been in controversy on this subject, the former attempting to explain the phenomena of microscopic vision on a dioptric basis, while the latter supports Prof. Abbe's views.

Prof. Lowne explains as follows † the advantages arising from the use of lenses with a large numerical aperture, and of immersion lenses respectively.

"The images seen with the Microscope are either brighter or darker than the illuminated field. An opaque object appears black, when illuminated from below it gives a negative image. A transparent object seen by transmitted light is less bright than the field, i. e. gives a negative image, whenever it absorbs much light, and whenever it has a lower refractive index than the medium in which it is mounted, except when it acts as a concave lens; it is brighter than the field whenever it has a higher refractive index than the medium in which it is mounted, except when it acts as a concave lens, i. e. it gives a positive image.

Diatoms have a lower refractive index than balsam, and seen by transmitted light should give, in the majority of cases at least, a negative image. Such a negative image is always complicated with diffraction images, and is only seen with object-glasses having a low numerical aperture. The dioptric image is necessarily feeble, as the diatom permits much light to pass through it, and delineation is only possible by means of diffraction images.

The case is, however, very different with high angles of aperture, and especially with immersion lenses; the diatom image is then positive; it is brighter than the field. How can this arise? The diatom is self-luminous, i. e. in the same sense as a piece of white paper is self-luminous. Every point of the diatom radiates light, and every point is an independent source of light, that is, the light radiates independently from every point, the vibrations proceeding in every possible phase at every instant, such light producing no visible interference phenomena.

The cause of the positive image is that the diatom is illuminated from above, not from below. It is illuminated by reflected light from the upper surface of the front lens of the objective.

It is well known that the pencil of light which falls upon a plate of glass is partially reflected chiefly from the surface of emergence. This surface of emergence of the front lens is a concave mirror, which condenses the reflected pencil upon the object. A very simple experiment

* Journ. de Microgr., xiii. (1889) pp. 481–2.

† Journ. Quek., Micr. Club, iii. (1889) pp. 360–72 (4 figs.).

will convince the most sceptical of the great illuminating power of the back of the front lens of an objective. Take a black-handled pocket-knife, the smaller the better, with a bright stud upon it, hold it up between the eye and a gas-burner, near the source of light; the stud is invisible. Take an ordinary pocket-lens of an inch focal length or thereabout, and without moving the knife, focus it upon the stud; it will be brilliantly illuminated.

Any convex lens will give a brilliant inverted image of a flame upon a small screen placed between it and the source of light, by reflection from its back surface. Moreover, if we look at the lens the virtual erect image of the flame seen on its back surface is nearly as bright as the source of light, although, of course, much smaller.

With objectives of large numerical aperture, the working distance is short, and with a large pencil much light is reflected upon the object. With immersion lenses the reflection from the cover-glass and the front of the objective is practically done away with, so that all the light reflected from the upper face of the front lens falls upon the object.

Five per cent. of the light which falls normally on the back surface of a glass lens is reflected, whilst the quantity which is reflected by oblique incidence rapidly increases; much light is totally reflected, the whole converges after reflection once, twice, or thrice towards the object, and it must be remembered that only the centre of the pencil falling upon the back surface of the front lens is transmitted to the eye, whilst the whole pencil is concerned in the illumination of the object from above.

I believe that this is the great advantage derived from high angles of aperture, and more especially from immersion objectives. The elimination of the false diffraction images resulting from the large illuminating pencil, and the reflection of light from the object, appear to me to be the causes of the great increase of definition attained by their use. The view propounded by Professor Abbe that they collect out-lying diffraction pencils, appears to me quite inadequate to explain the increase of definition."

Mr. E. M. Nelson refutes Prof. Lowne's suggestion by the following considerations: *—"One great objection to the dioptric theory is, that it is unsupported by experiment. The single experiment put forward may be said to touch the subject only in an indirect manner. I allude to the reflex from the objective front, to which I shall refer later.

(1) The point with regard to the images of the condenser diaphragm at the back of the objective has nothing to do with the question.

Let us take a simple case—viz. an oil 1/8 of large angle focused on a *P. angulatum*, illuminated by edge of flame, centered and focused by stopped-down condenser on object in usual manner. Now, if we examine the back of the objective we shall see the usual picture of the dioptric beam and the six spectra round it. The size of the dioptric beam—i. e. the disc of light at the back-lens of the objective—will depend on the size of diaphragm and angle of condenser. The size of the spectra will equal the size of the dioptric beam. If the object be now taken away, we shall lose the spectra, but not the dioptric beam. Now, no one imagines for a moment that this image of the diaphragm is projected to a focus at the objective conjugate; what is projected there is an erect image of the edge of the flame. If the object be replaced, there will be

* Eng. Mech., xlix. (1889) pp. 425–6 (4 figs.).

an inverted image of it, in the erect image of the flame, independently of any spectra.

Now with regard to the spectra. I well remember that the first experiment I performed when the diffraction theory was new was to receive the images on a piece of oiled tissue-paper at the objective back. If my memory serves me right, you can trace an image of *P. angulatum* about half an inch from the objective back. The images will necessarily be much out of focus, but, nevertheless, they can be made out. There were black outlines on a light ground in the dioptric beam, and a green image in each of the six spectra. Remove the greased paper screen further back from the back lens, and the six spectral images were seen to coalesce with the central dioptric image. The point to be learned from an examination of the back of the objective is the size of the cone, or cones, which form the image at the objective conjugate.

Thus, the dioptric image of a point in the object is formed by a cone, the base being the bright disc at the objective back. A spectral image is formed by a cone, the spectral disc being its base, and so on. I am of opinion that Prof. Abbe has established experimentally and theoretically that the delineation of this microscopic image of the fine structure of *P. angulatum* depends on the fusion of these green spectral images with the dioptric beam and with one another.

(2) The next point is the extinction of the spectra by the dioptric beam, or, more correctly, the effect of the spectra is so feeble in comparison to that of the dioptric beam, that their power to influence the image is practically *nil.*

The answer to this is, that just as much as you increase the diameter of the dioptric beam, so do you increase that of the spectra—a fact which may be experimentally verified in two minutes. Thus, expand the illuminating cone until it nearly touches the expanded spectra, now stop out the dioptric beam, and look at the brightness of the spectral image. Then, without moving the stop, reduce the illuminating cone, and watch the diminution in the brightness of the spectral image.

Of course, it is impossible to carry on the experiment when the dioptric beam overlaps the spectra, as it is impossible to cut out the dioptric beam without cutting out the spectra as well. But it is for the "dioptricians" to show why the brightness of the spectral image should cease to increase at the point when the dioptric beam overlaps the spectra. The brightness of the spectral image most certainly increases as you increase the dioptric beam as far as you can carry on the experiment, and I can see no possible reason why it should not go on increasing until you reach your maximum cone.*

(3) The following experiment, although not proving the matter, points very strongly in favour of the diffraction and against the dioptric theory. Examine a *P. angulatum* with a lens which, when illuminated by a narrow pencil, will not grasp the six first-order spectra, and enlarge the cone until the dioptric beam occupies, say, 3/4 of the back. Now, if a lens of suitable angle has been chosen, the expanded spectra will just cut into the peripheral zone of the objective. If the eye-piece is replaced, delineation will be seen; but if a stop be placed over that peripheral zone, although the large dioptric beam remains the same, the delineation will have vanished. If the image is a dioptric one, why, in the presence

* Unless the experiment has been tried, one would hardly believe the great brilliance of the spectral image when the dioptric beam has been stopped out.

of such a large dioptric beam, are those little edges of spectra in the peripheral zone so supremely important?

(4) You cannot have an irregular picture from a spectral image. A short time ago I also held this view, and I used to assign the irregularities in the microscopic image to a function of the dioptric beam; but special experiments, made with a view to determine this point, have altered my opinion. In a purely spectral image I have seen irregularities in the microscopic image, such as a missing dot, &c. These differences are not clearly seen, and yet they are seen. I do not for one moment say that the dioptric beam has no influence on the image—it has a very great influence; in fact, a greater influence than perhaps any spectrum taken by itself; but that is quite another matter altogether to saying that the microscopic image is a purely dioptric one.

(5) The reflex from the front lens. This is the only part of the dioptric theory which has been supported by experiment. It is very well

Fig. 104.

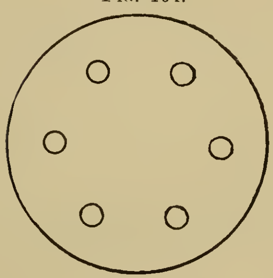


Fig. 105.

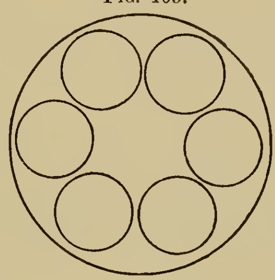


Fig. 106.

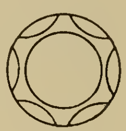
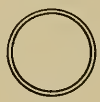


Fig. 107.



Explanation of Figs.

Fig. 104.—Shows back of objective, with spectra of first order of *P. angulatum*, the dioptric beam of small angle being stopped out. The diatom will be resolved on a dark ground, and will be fairly bright.

Fig. 105.—The same, with a dioptric beam of larger angle. The diatom will be resolved and intensely lighted on a dark ground.

Fig. 106.—The same, with a smaller aperture, so as to admit only the edges of the expanded spectra. The dioptric beam is now present, and the diatom is resolved on a light ground.

Fig. 107.—The same, aperture of lens reduced, so as to cut out the edges of the spectra; dioptric beam same as in fig. 106. The diatom is not resolved.

known that an object, such as a diatom, illuminated by a central axial cone, appears brighter than the field.

The "dioptricians" explain this fact by saying it is caused by light reflected from the front lens of the objective, and this statement is supported by the experimental examinations of opaque objects mounted in balsam.

I have very grave doubts as to the opacity of some of these objects which shine so brilliantly; therefore, let us pass on to one object upon which there can be no doubt—viz. the mercury globule.

On examination, a mercury globule exhibits a feeble illumination from the reflected light. A great deal depends, however, on the curvature of the front lens, which, of course, differs in lenses of different constructions. It was found on trial that a certain dry 1/4 gave brighter illumination than another dry 1/4, also both 1/4's gave more brilliant results than a certain oil-immersion 1/8. It was also found that the effect was heightened by racking up the condenser much within its focus.

It is not difficult to calculate to what focus light, radiating from the principal focus of the lens, will be brought by reflection from its posterior surface.

Let us examine a particular case, say a hemispherical lens of 1/10 in. radius, of crown glass, ref. index 1·5. Then by ordinary formula—

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{r} + \frac{1}{s}\right)$$

$$f = 1/5.$$

Now we have to find the apparent curvature of the concave surface as seen through the plane.

By formula—
$$R = \frac{Ff}{F - f}*$$

where R is radius of curvature, F principal focus, and f the apparent radius of reflecting surface seen through the plane—

$$1/10 = \frac{1/5 f}{1/5 - f}$$

$$f = 1/15.$$

The next point we have to determine is the focus of a concave mirror of 1/15 radius for rays coming from a radiant 1/5 in. in front of it. By formula for a concave mirror—

$$\frac{1}{p} + \frac{1}{p^1} = \frac{2}{r}$$

$$\frac{1}{p} + \frac{1}{1/5} = \frac{2}{1/15}$$

$$p = 1/25.$$

Therefore we see the reason why the illumination by reflection from the posterior surface of the lens should be feeble; because it is brought to a focus within the lens, and by the time the rays come to the object they are greatly dispersed.

When the condenser is racked up, the radiant is placed nearer the concave surface, and its conjugate focus brought nearer to the object, and consequently the illumination of it is strengthened. Therefore we can see that the single experiment put forward in support of the dioptric theory fails.

6th and last point. It is an established fact that the most critical of all images are those on a dark ground. Here an objective is put on its mettle, and its resolving power strained to the utmost. It is a great pity that certain technical difficulties come in the way of this kind of illumination with wide-angled lenses. Here we have no dioptric beam, nothing but spectra, and we get a "true" image—i. e. one that

* Formula by C. V. Boys, F.R.S., in "Measurement of Curvature and Refractive Index," 'Philosophical Magazine,' July 1882.

behaves like a daisy under a 4-in. on focal alteration. Such a case is quite inexplicable by a dioptric theory; but is quite consistent with the views put forward in my last paper. When the back of the objective is examined, it will be seen entirely covered with spectra, so no zonal differences can exist, and consequently focal alterations will not produce different images. The above seem to me to be the chief objections to the dioptric theory.

In conclusion, let me say that the author of the dioptric theory has done excellent work, although according to my own view he has failed to establish his case. First, he has given the most concise and lucid explanation of the interference phenomena that is extant in our language. Secondly, he has given testimony to the fickleness of images derived from a small cone of illumination."

Mr. L. Wright * also writes on the same subject:—"I have myself very grave doubts if this new theory is correct; but it is a singularly interesting one. I draw attention to it partly as a proof that speculation is not yet at an end, but chiefly to point out that there is one most simple experiment, easily made, which will determine it with absolute certainty. That is, to *silver the back* of the front lens, and then remove the silver from the centre of the back only. The reflection from the margin will be, if anything, rather increased; and whatever becomes of the theory in question, I believe the expedient may prove of some service as an illuminator of certain objects, and may give valuable resolution of structure by the modification in this point. But the silver will really stop off all but the central pencil, which it will allow to pass unaltered; and if Prof. Lowne's theory is correct, the 'high' resolution will be unaffected. I hope such an experiment will be made without delay, and it will be well worth while merely as one in illumination, if no one has attempted it before. I am afraid, however, it will demolish the theory, for if the latter be sound, one would say that *all* lenses with hemispherical fronts ought to give equal resolution, irrespective of aperture, which belongs to the *back* portion of the lens. This is not the case, and I fear we have yet to find a theory which shall reconcile the undoubted facts with conclusions that seem forced upon us by the phenomena of physical optics."

In reference to Mr. Wright's suggestion, Mr. Nelson † points out a way in which the experiment may be performed without silvering the front lens of an objective.

An inch objective with a Lieberkühn ought to resolve more than the same lens without a Lieberkühn with transmitted light, supposing the hypothesis to be correct. If the increase of aperture is only useful for illuminating the object by reflected light, and no rays pass through the increased portion to the eye, it is abundantly evident that those conditions are fulfilled by a Lieberkühn. The experiment can therefore be easily tried.

Prof. Lowne remarks ‡ on Mr. Wright's paper as follows:—"I fear the theory which I have suggested to account for the efficacy of large apertures in microscopy cannot be so easily verified or disposed of as Mr. Lewis Wright supposes. Before giving my reasons, I must correct the impression which may evidently be made by an expression of mine, and which it was far from my intention to convey.

* Engl. Mech., xlix. (1889) p. 391. † T. c., p. 416. ‡ T. c., pp. 437–8.

In using the words quoted by Mr. Lewis Wright, 'Only the centre of the pencil falling on the back surface of the lens reaches the eye,' I was speaking of the intensity of the light illuminating each portion of the object, and all I meant was that the effective emergent pencil which enters the pupil is small as compared with the angular aperture of the object-glass.

I admit that the sentence is ambiguous, and should have been more clearly worded; but I never intended to convey the idea that the back face might be silvered, leaving only a small aperture.

The idea of silvering the lens, as Mr. Lewis Wright suggests, did cross my mind when I was working at the subject, but I saw at once that it could not be used as a means of settling the question, and for this reason. The object-glass is made experimentally, and the outer zone is of the utmost importance, as it is far more easily corrected to give a sharp image than any other part of the lens.

It will be readily seen that if the lens surface be divided into a number of concentric zonular elements, the more nearly these approach the centre of the lens, the less the angle their normals make with direct incident light.

If the aperture were small enough the lens would have practically plane surfaces, and could not give any distinct image other than that given by a pinhole. The outer zones are so corrected that the pencils passing through them come to the same foci as the central pencils—that is, their chromatic and spherical aberration is reduced to a minimum, whilst the intermediate zones are left uncorrected. If by any diaphragm or other appliance the outer zone is rendered ineffective, the next outermost zone must be corrected.

I do not know whether it would be possible to reduce the apertures of an objective, and re-correct the glass without increasing its working distance. If this were possible, the glass might regain the definition lost by the reduction of aperture, provided this reduction were not great; but the experiment would be one of great practical difficulty, and could only be carried out by one of the best makers of lenses, and then only with great expenditure of time. I fear we shall have to be satisfied with some less direct method of settling the question.

In my own mind there is no doubt whatever that all definition would be destroyed by silvering the back face and reducing the aperture, which is practically the same thing as putting a diaphragm behind the objective, whether the image is a purely dioptric or a diffraction phenomenon, unless some compensatory change could be made in the glasses without altering the curve of the front lens or its working distance.

I would remind microscopists that what I have said applies only to critical images with high powers, and I would ask them to compare such images with those seen by dark-ground illumination and lower powers. The resemblance between the images produced by the two methods of illumination is very striking."

Prof. Abbe himself has also sent a paper to the Society (now in process of translation) refuting Prof. Lowne's suggestions.

Ultimate Structure of the Pleurosigma Valve.—At the October meeting Mr. T. F. Smith read the following paper:—

Twelve months ago I had the honour of bringing before you some researches on the valve of *Pleurosigma*, and claimed to have discovered that what up to that time had been considered a single plate of silex was really built up of two or three layers of structure. I also claimed to be the first to call attention to this fact, but this claim I must now withdraw, for the simple reason that I find on page 680 of the Journal of this Society for 1879 the following passage from a paper by Herr Grunow—with additional notes by Mr. Kitton—on the Diatomaceæ of the Caspian Sea:—

Speaking of *Pleurosigma attenuatum* and *P. hippocampus*, Herr Grunow says:—"The structure of these allied forms under high powers appears very similar; between the strongly marked lines of beads faint outlines of other beads may be seen. Whether these delicate puncta belong to a second valve or are an optical delusion must remain for the present undecided; it is certain, however, that the valves of *Pleurosigma* are composed of two layers, which separate when acted upon by long boiling in acids." And then between brackets, I suppose by Mr. Kitton, "I have seen this in *P. angulatum*." Then follows this note by Mr. Kitton:—"The faint markings here alluded to have been seen by other observers. It is most probable that the valves of *Pleurosigma* have a similar structure to many other diatoms in possessing what I call secondary valves, which in some genera are like, and in others unlike the primary valve."

The above passages show how remote the chances are of any single individual being the sole discoverer of any new fact, whether important or trivial; and although the only positive evidence given here is the separation of the layers by boiling in acids, it is enough to bar my claim to be the first to call attention to the compound structure. I think, however, I may still claim to be the first to figure the structure of the different layers, and am pleased to feel that my attempts in this direction will derive additional weight from being corroborated by the testimony of two such eminent observers as Herr Grunow and Mr. Kitton.

It is almost necessary to apologize for bringing this subject before you to-night, as for some reason the study of diatoms in the present day is almost a discredited one, and the microscopist who indulges in it is looked upon as nothing better than a trifler in science. But I think this stigma is an unjust one if we look at the important part the resolution of diatoms has played in the development of the modern objective, and thus placed in the hands of microscopists generally an efficient instrument of research, without which many pages of Nature must have remained a sealed book. The study of diatoms has also its value—and with many its chief value—in their being one link in the great chain of existence; but it is purely from a brass-and-glass point of view I wish to approach them to-night, and using them as a standard of value, try to prove by the results of my investigations on the *Pleurosigma* valve, how much further it is possible, by the use of the new optical glass and proper methods of illumination, to push our researches into the nature of all minute structures.

Practically, the resolving power of our objectives on lined objects had reached its maximum before the advent of the new glass. The *Amphipleura pellucida* marks now, as it marked then, the finest known regular structure of any regular object. There was nothing further, then, to be gained in resolution, but possession of one of the new apochromatics, with its entire absence of colour, soon convinced me that it possessed a power of separating different layers of structure altogether outside the grasp of the ordinary achromatics. The result of this increased power in my hands was to enable me to split up the supposed one plate of silex forming the valve of *P. formosum* into three, and thus add two more vertical notches to the standard by which we measure our objectives.

The advantage of applying such increased power to the elucidation of minute structure generally is so evident, that it is only necessary for me to place the existence of the compound structure and its character beyond a doubt to leave the matter in your hands to apply for yourselves.

When I had the honour of bringing this question before you twelve months ago, I was met by the objection that the appearances I described were diffraction effects—meaning false effects—and was asked if I had examined the diatoms mounted in a dense medium as well as when mounted dry. After the exhaustive manner in which diffraction has been discussed within the last twelve months, and the modification of opinion to which that discussion points, I do not think it necessary to meet the first objection; but on the second point I may say that I have since examined a slide of *Pleurosigma formosum* mounted in phosphorus, and found all my previous opinions confirmed. There has also cropped up from time to time the objection that the interference of light coming through a grating, and the impossibility of separating two such gratings —if they existed—from each other must vitiate any conclusions that might be drawn from mere visual appearances. I recognize the force of the last objection, but at the same time beg to point out that within certain limits it applies rather to the old dry objectives of narrow aperture than to the new oil-immersions. With the latter the depth of penetration is so little that if two layers are separated by ever so narrow an interval, for all chance of interference they might as well be a mile apart. Of course, in asserting this I am supposing a large central cone of light, as being the only correct method of illumination with such a glass, the slightest deviation from which will produce error. But even with an oil-immersion of wide aperture it is still possible for two layers to be so closely connected that interference occurs, and no doubt, under such circumstances, it would be impossible to be sure of the structure. Had no other method been adopted by me than to record an appearance as true simply because it appeared such under the Microscope, I should deserve all the censure you could apply to such a method of working. Such, however, has not been my method, but when there has been the slightest doubt, I have formed no definite opinion of any structure until seeing it isolated from everything which could interfere with the definition. Thus three layers of structure have been figured by me in *Pleurosigma formosum*, because I have been enabled to isolate them, but I have never ventured upon describing more than two in the other species of this genus, although one might be led by analogy to suppose there were three. Leaving out the question, then, of the middle layer in the finer forms as one on which I can offer no direct evidence, the task is much simplified when trying to prove the existence of two layers in *Pleurosigma angulatum*, it being necessary only to deal with the two opposite sides of the valve. On looking over a spread slide of this diatom, mounted dry, we at once discover that different valves present different optical appearances, and on further examination shall also find that the different valves have different curves, and that the same curves and appearance always belong to each other. The prints here to-night marked 1 and 2 will illustrate this. Both are taken across the nodule, and while No. 1 starts straight from the median line and slopes down towards each edge, No. 2 starts straight from the edge and slopes down towards the median line. Now, if these two curves are placed opposite each other, there will be a considerable space between them, and we are driven to this conclusion, that either each side represents a different layer of structure, or we have one very thick plate of silex—a supposition quite at variance with what we know of diatom structure generally.

I have said that the same appearance is always identical with the same curve of the valve—No. 1 showing white, and No. 2 black interspaces; but this only on condition that the largest cone of light possible is poured into the objective. With a narrow cone of illumination the two sides present the same image, but by using the largest aperture of the achromatic condenser, and placing the bull's-eye condenser between it and the mirror, the valves become at once differentiated in a manner unmistakable.

I may state here incidentally that it is not possible to develope the structure such a glass is capable of showing; with only the edge of the flame and dry achromatic condenser the bull's-eye added between is necessary, and with this the use and expense of an oil-immersion condenser is quite unnecessary. Of course I am aware that the aperture is measured by the back lens of the objective. I know that the back lens of an oil-immersion of 1·4 N.A. can only be filled with the use of an oil-immersion condenser on an object mounted in the same refractive index; but I also know that the objective has not yet been made which will allow the back lens to be so filled with light without utterly breaking up the image. The full aperture of such a lens, then, can never be utilized, and the use of the bull's-eye condenser will allow as much of it to be used as is practicable.

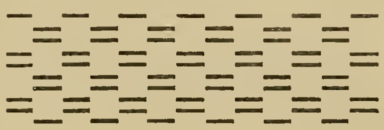
I am aware that my prints of *Pleurosigma angulatum* do not agree with the celebrated print by Dr. R. Zeiss, exhibited here at the meeting held on April 11th of last year, and which received the highest praise at that time from some of our leading microscopists as being the greatest advance yet made in the delineation of that diatom. I admit it to be a very striking picture, that photographically it is deserving of all praise; but the conditions of its production are in violation of every principle laid down by Dr. Abbe himself in his different papers on the theory of microscopic vision. First it is a most flagrant example of what Dr. Abbe calls empty magnifying power; and secondly, the image is false, for the reason mentioned in his paper on the Relation of Aperture to Power, wherein he shows that where the magnifying power of an objective is pushed up much beyond the number of diameters necessary to show the details resolved by the aperture, all details under such circumstances, whether square, triangular, or lozenge shape, acquire the same appearance of being round or oval. What then has happened in this particular instance? The aperture of the objective by which the photograph of Dr. Zeiss was produced has been narrowed down by insufficient illumination from 1·3 N.A. to 0·70; the power has been forced up to 4900 diameters, and the result is circles where there should be squares or hexagons. 4900 diameters is more than 40 times the initial power of the objective used, even if all the aperture had been utilized; what then can be the value of such an image as a truthful interpretation of structure when produced with little more than half that aperture? In taking up this position with regard to the relative truth of the respective prints, I am asserting nothing but what is within my own knowledge; both Mr. Nelson and myself having produced exactly the same photographic image as Dr. Zeiss with the dry apochromatic 1/4 in.

But to recur to the proofs of the compound structure of the *Pleurosigma* valve. It is not necessary that I should weary you by giving in detail all the evidence I have collected, but will call your attention to two prints only of a valve of one of the *Pleurosigma* I have taken at two different planes. In both prints a bit of the valve is shown chipped away, but while in the print taken at the lower level, the hole is clean through, in the upper a fine grating is seen projecting over the hole, and nothing, I think, can be more conclusive of different layers. Having done my best to establish the existence of different layers in the *Pleurosigma* valve beyond a doubt it now remains to determine, if possible, the ultimate structure of each layer in one species, and then to establish the nature of the ultimate structure as between one species and another in the same genus. When a number of forms agree in shape and their leading features, and the only difference between them is the relative coarseness or the fineness of their structure, you cannot draw a line and say, "Here ends truth and here begins error." It must be true throughout or false throughout, and to establish the truth of the one will establish the truth of the other. Let us see then; first, what are the leading features common to all the *Pleurosigma*, and secondly, how far we can make sure of the ultimate structure of the coarsest form, that is of *Pleurosigma formosum*. It is not necessary to say anything about the common shape which gives name to the genus, or the median line, to an assembly like this, but I may mention one peculiarity of the nodule common to all the species having the diagonal markings which I do not think has been mentioned before. On one side of the valve there is simply a cavity at that point, but on the other side the median line at the nodule is joined as in fig. 108. My attention was first called to this by examining a type-slide of the *Pleurosigma*, where I found it in form after form. Another feature common to the same forms, is two rows of perforations larger than the others running lengthways on the valve, one on each side of the median line and two similar rows, one on each outer margin. Lastly, in all the species having diagonal markings there is the common feature of the structure being composed of a square grating with a focal image formed in each alternate square. This is enough, I think, to show that whatever the structure may be it is of the same character throughout, and it now remains by examples to find out if possible, what is the unit of that structure.

Fig. 108.

Whatever difference of opinion there may be about the truth of the image of a structure when it recurs at regular intervals, there can be none when you get an isolated particle or fibril, which, existing already as a unit, cannot be the double or the quadruple of another unit. Such a unit I have found of the structure of *Pleurosigma formosum* floated entirely away from the valve. It seems to consist simply of a series of short bars of silex placed lengthways on the valve, side by side, in such a manner as to leave alternate interspaces between them (see fig. 109). It will be seen from a study of this diagram how the ordinary appearance of the *Pleurosigma* is produced. The larger interspaces, being produced alternately, are seen running diagonally across the valve, and an image of the larger interspaces, thrown there from the under layer as on a screen, gives rise to the appearances which have produced so much controversy as to whether the "markings" are beads or perforations. As a matter of fact they are neither, but simply a collection of focal images or ghosts, and you may as well speak of the picture thrown by the optical lantern on a screen as the structure of that screen, as speak of these focal images as the structure of the diatom. I have a valve of *Pleurosigma formosum* under the Microscope here to-night which shows finely the arrangement of the fibrils on the valve. In some parts of the valve the fibrils are seen lying loose, in other parts close together, forming regular structure, while in other parts they are wanting altogether. A print of the same valve shows in parts a regular collection of white "beads," which are ghosts and utterly wanting where the outer membrane is torn away. The distance apart of the alternate squares from the centre of each other on *Pleurosigma formosum* is double that of *Pleurosigma angulatum*, and our difficulty is enormously increased when we try to determine the structure of the latter. To me it is sufficient that the two images present the same characteristics to convince me that the structure is the same, but I know that other observers want more positive evidence, which for a long time I was unable to give. What was wanting was corresponding torn structure, and at last I am able to put that in evidence also—not, I confess, in *Pleurosigma angulatum* proper, but in an allied species, which for our purpose is practically the same. The striæ are of the same fineness—50,000 to the inch; there is the same arrangement of large perforations on each side of the median line and the margins; and the finer structure shows the same focal images formed in alternate squares. On one corner of the valve of which I show a print, the outer layer is stripped off, leaving the under one intact—found on focusing down—while on the lower corner the fibrils are lying in strips, and are of exactly the same character as those we have seen in *Pleurosigma formosum.*

Fig. 109.



Disturbances of Vision consequent on Microscopic Observation.*—M. C. J. A. Leroy has noted a peculiar disturbance of vision which affects exclusively the eye which has not been employed during microscopic observation. Letters seen at the usual testing distance of 5 m. were blurred, and this effect was not corrected by spherical glasses or by efforts of accommodation. In the table of radiating lines used as diagnostic for astigmatism, the horizontal lines were disturbed while the vertical ones remained clear, and no cylindrical glasses modified the difference: thus the disturbance was not due to defect in accommodation or to simple astigmatism. The author was led to the conclusion that it is a diplopia always produced in a vertical direction by noticing the fact that the horizontal lines of the curtain traversing the top of the machine gallery in the Paris Exhibition was distinctly double. This diplopia has its origin in the dioptric apparatus (cornea or

* Comptes Rendus, cviii. (1889) pp. 1271-3.

crystalline) of the eye and not in the cerebro-retinal centres, for on examining a horizontal line through a small hole from 0·8 mm. to 1 mm. one of the images only was seen, but both became successively visible on displacing vertically the hole, and on impressing a suitable velocity on this displacement an undulatory appearance was given to the line. No phenomena of double refraction were observed on examining with a nicol. In certain instances triplopia was also obtained, the third image, however, being very pale. The energy and duration of the disturbance was naturally found to vary with the length of microscopic observation, and its disappearance was progressive and continuous. Thus, on one occasion, when the author began work (observation of diatoms) at 10 in the morning, at 10.30 there was diplopia, and at 11 triplopia. The separation of the images was then measured and amounted to 4′ for the second and 8′ for the third. At noon the triplopia had disappeared, but diplopia still remained.

Apart from microscopic observation diplopia was also found to result from observing across a small hole a phenomenon difficult to catch at the moment of its appearance or disappearance in a very limited field, and also in some degree from examining ophthalmometric images.

M. J. J. Landerer,* in reference to M. Leroy's note, claims to have been the first to call attention to this phenomenon, and adds the following remarks concerning it:—

(1) Although the effort experienced by the eye seems to be of the same nature for microscopic as for telescopic vision, yet the disturbance consequent in the closed eye is much more marked in the first case than in the second. This difference is maintained not only when the telescopic object is so difficult a one to catch with a telescope of 108 mm. aperture as the shadow of the second satellite of Jupiter as it is projected on the edge of the planet, but also when the image has considerable brightness, as when the granulation of the sun's surface or the spots are examined through only a slightly blackened glass. This difference is not due to the different inclination of the head in each case, for it still persists when the telescopic observation is made by means of the bent eye-piece.

(2) That during microscopic observation there is a crossing of the optic axes of the two eyes, producing an effect similar to that of strabism, is proved by the fact that by giving them this disposition, and then applying the eye to the eye-piece, the image is seen with perfect distinctness.

It is the simultaneous effort of both eyes which explains the disturbance undergone by the closed eye. But as this effort acts in an unconscious way, and has struck no one's attention, it has been supposed that there is here only an effect of accommodation producing the definition of the image at the distance of the *punctum proximum*. The above facts appear really to show that this is not the case, or, at least, that there is no reason to affirm that the image is not defined at the distance of distinct vision properly so called.

Amplifying Power of the Microscope.†—Dr. L. Didelot has applied to the Microscope the notions and formulæ concerning the amplifying

* Comptes Rendus, cix. (1889) pp. 74–5.

† Didelot, L., 'Du Pouvoir amplifiant du Microscope: détermination théorique et expérimentale suivie d'une table à quatre décimales des inverses des 1000 premiers nombres de 0·01 à 10·00,' 2nd ed., 8vo, Paris, 1887, 86 pp. (1 pl.).

power of optical instruments as given in the latest discussions on the subject, and gives an experimental determination of the dioptric, and thence the amplifying power of the Microscope by the methods used in the Laboratory of Medical Physics of the Faculty of Lyon. At the end of his paper he gives a table of the inverses of 1000 numbers from 0·01 to 10·00, by which dioptrical calculations are much simplified.

The conditions of visibility of an object seen by the naked eye and under constant illumination depend on the linear dimensions of the object, its distance from the eye, and on the acuteness of vision. If y is the absolute length of the object, and l its distance from the eye, the visual angle is proportional to $\frac{y}{l}$. The acuteness of vision is in the inverse ratio to the minimum visual angle under which two separated luminous impressions are distinguished, so that if v denote the degree of visibility of an object seen by an eye of acuteness V, we have

$$v = \mathrm{V}\frac{y}{l}\,.$$

For an eye assisted by any optical apparatus, the four magnitudes v, V, l, y will take new values v', V$'$, l' y', y' denoting the image of y. The ratio of visibility of image and object W is then given by the equation

$$\mathrm{W} = \frac{v'}{v} = \frac{\mathrm{V}' y' l}{\mathrm{V} y l'}, \qquad (1)$$

which may be written

$$\mathrm{W} = \frac{\mathrm{V}'}{\mathrm{V}}\cdot\frac{a'}{a} \qquad (2)$$

by replacing the ratio of the trigonometrical tangents $\frac{y'}{l'}$ and $\frac{y}{l}$ by the angles a' a under which image and object are seen, or by the arcs which they intercept on the retina. For the same eye V = V$'$ and the ratio of visibility becomes the amplifying power Γ, which M. Monoyer defines as "the ratio in which an instrument increases the apparent magnitude of objects," and we have

$$\Gamma = \frac{a'}{a}\,.$$

The object of a magnifying instrument is to increase the visibility of objects. Formula (1) shows that this can be attained either by diminishing l', as in the simple magnifier, or in augmenting y' as in the projection-lens or solar Microscope, or, finally, in uniting both, as in the compound Microscope. The degree of visibility, then, does not depend solely on the *magnification* (*grossissement*), i. e. on the ratio of the absolute dimensions of image and object, but also on the distances from the eye; and it is to a confusion between *magnification* and *amplifying power* (*pouvoir amplifiant*) that many erroneous results are to be attributed. Thus, the formula given by many authors, $\mathrm{G} = 1 + \frac{\mathrm{D}}{f}$, introduces the distance of distinct vision D, but neglects the distance of the lens from the eye. The older formula $\mathrm{G} = \frac{\mathrm{D}}{f}$ in use up to the beginning of the century, is still more inaccurate. It is of little importance, in order to distinguish the details of an object, that its aerial image should be much magnified, since it is so much the further from the eye, and so its apparent diameter is diminished. It is the image on the retina which should be magnified, and the effect of a lens will be measured by comparing the retinal images of the same object seen successively through the instrument and by the naked eye. By following up this principle, which had been previously grasped by Verdet and Guebhard, M. Monoyer has obtained a general formula applicable to all optical instruments.

Thus, taking the case of a simple lens represented by its principal planes reduced to a single plane H K (fig. 110) at a distance d_0 from the nodal points of the eye united at the point O, let $P Q = y$ be an object situated perpendicularly to the optical axis of the eye at a distance from the lens less than its principal focal length $F H = f$. Join P and its image P′ to O, and prolong these lines as far as the retina; let α and α' be the angles which these rays make with the optic axis, and let l and l' be the distances of object and image from O. Then if Γ denote the amplifying power, G the magnification, and L′ the inverse of l'

$$\Gamma = \frac{\alpha'}{\alpha} = \frac{y'}{l'} \cdot \frac{l}{y} = \frac{y'}{y} \cdot \frac{l}{l'} = G\, l\, L';$$

i.e. the amplifying power of an optical instrument is equal to the product of the magnification by the ratio of the distances of the eye from the object and its image. In the case of the simple lens M. Monoyer distinguishes several kinds of amplifying power.

(*a*) Relative amplifying power, corresponding to $l = 1$, i.e. comparison of the retinal images when the object is situated at an invariable distance of 1 metre from the eye.

We have then

$$\Gamma_r = G\, L'. \tag{4}$$

But

$$G = q'\, F \tag{5}$$

where $F = \frac{1}{f}$ and q' is the distance of the image from the second principal focus F′ and $= l' + f - d_0$.

∴ by substitution

$$\Gamma_r = (l' + f - d_0)\, F \,.\, L' = F + L'\,(1 - d_0 F). \tag{6}$$

This expression is identical with that which gives the dioptric power $\Phi_{FL'}$ of a binary system composed of two diopters of powers F and L′.

In the case of the compound Microscope the dioptric power and focal length are of opposite sign. Denoting these by Φ and ϕ respectively, we have

$$\Gamma_r = -\,(\Phi - L' - d_0\, \Phi\, L'). \tag{7}$$

Formula (6) serves to show the influence of accommodation; for take the case of the lens close to the eye and $d_0 < f$; then the term $1 - d_0 F$ is positive, and the amplifying power augments with L′. The accommo-

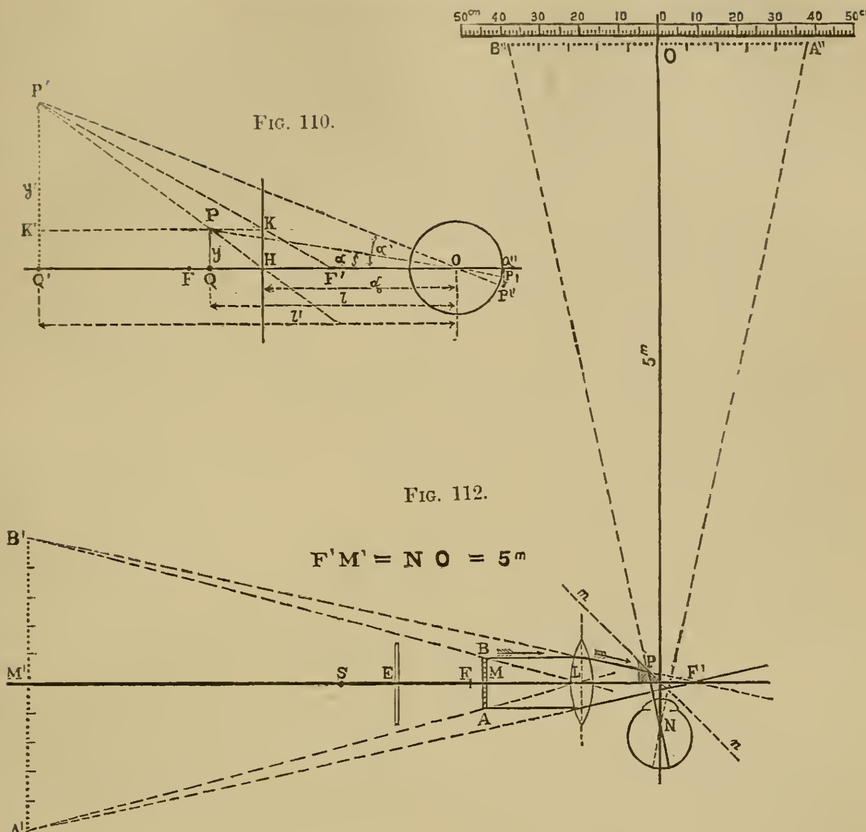


Fig. 110.

Fig. 112.

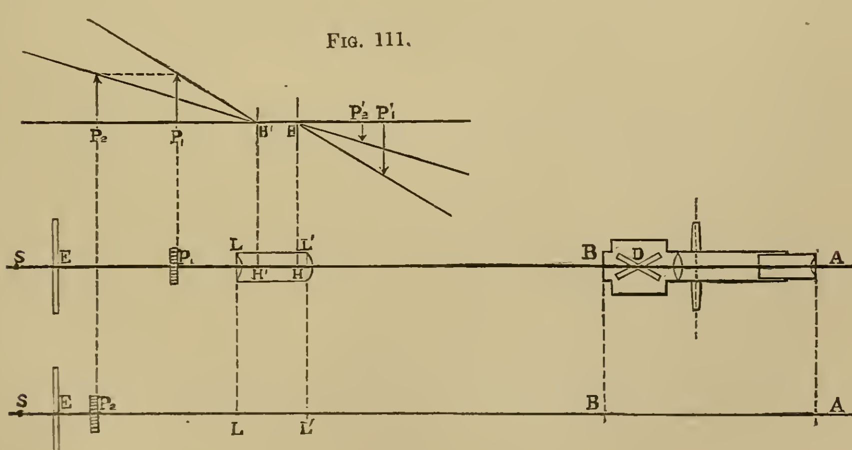


Fig. 111.

dation, therefore, should be as large as possible, so that the image might form as near as possible to the eye. If, on the other hand, $d_0 > f$, $1 - d_0 F$ is negative, and to augment the amplifying power L' must diminish, i. e. l', the distance of accommodation, must be as large as possible. The most advantageous case is that of a hyperpresbytic eye, in which case L' is negative. For the Microscope the conditions are inverse.

(*b*) Comparative amplifying power corresponding to the case in which $l' = l$, i. e. the image is compared with the object supposed to be placed at the same distance from the eye.

In this case we have

$$\Gamma_c = G.$$

(*c*) Absolute amplifying power, which represents the proper action of the instrument supposing the object placed at the same distance from the eye assisted by the instrument as from the naked eye.

We have

$$l = d_0 + f - q,$$

where q is the distance F Q,

$$= d_0 + f - \frac{f^2}{q'}. \tag{8}$$

Substituting in formula (3) we have

$$\Gamma_a = G\,L'\left(d_0 + f - \frac{f^2}{q'}\right)$$

$$= 1 + d_0 F (1 - d_0 L') \tag{9}$$

on replacing G and q' by their values q' F and $l' + f - d_0$ respectively. Where the principal space ϵ cannot be neglected,

$$l = d_0 + f - q + \epsilon,$$

and the formula becomes

$$\Gamma_a = 1 + d_0 F (1 - d_0 L') + \epsilon \Gamma_r.$$

When either the relative or absolute amplifying power is known, the other can be determined by the connecting formula

$$\Gamma_a = \Gamma_r \times l. \tag{10}$$

For the simple lens, Microscope, or ophthalmoscope the consideration of the relative is of more importance than that of the absolute amplifying power; but for telescopes or spectacles, in the use of which we are not free to modify the distance of the object from the eye, the absolute amplifying power alone can be used.

For the case of the astronomical telescope, where the dioptric power is zero, M. Monoyer * has given the formula

$$\Gamma_a = \frac{F_2}{F_1}\left[1 + \frac{1 + (d_1 + d_2) F_1}{q F_1}\right]\left[1 + \frac{(1 - d_2 F_2) L'}{F_2}\right], \tag{11}$$

* Comptes Rendus, June 18th, 1883.

F_1 and F_2 denoting the dioptric power of objective and eye-piece, d_1 the space between the first principal point of the objective and the second principal point of the eye-piece, d_2 the distance of this latter point from the first nodal point of the eye, l' the distance of accommodation, and q the distance of the object from the first focus of the objective.

More recently M. Monoyer has arrived at a formula more particularly applicable to spectacles, viz.

$$\Gamma_a = \frac{1 - d_0 L'}{1 - d_0 L} \cdot \qquad (12)$$

A comparison of different formulæ for the magnification shows that the majority of authors, such as Martin, Deschanel, Jamin, use formulæ belonging to the form

$$G = \frac{l' + f - d_0}{f} = 1 + \frac{l' - d_0}{f},$$

in which l' is the distance of distinct vision.

The magnification thus defined answers to the comparative amplifying power, if we make $l = l'$.

The consideration of the formulæ proposed by Rees, Verdet, and Guebhard shows that these authors, in order to appreciate the influence of the lens on the visibility of an object, have had recourse either to the magnification or to the relative amplifying power. M. Panum alone has calculated the absolute power. The conclusion drawn by the author is that M. Monoyer's formula possesses a degree of generality and simplicity which warrants its adoption in preference to all others.

In the experimental determination of the amplifying power of the Microscope, use is made of the fact shown by formula (6) that under two circumstances the amplifying power Γ_r becomes equal to the dioptric power F, viz. when $L' = 0$ or when $d_0 = f$. A determination of the dioptric power for the latter case when the second focus coincides with the first nodal point of the eye, consequently gives the amplifying power.

Two methods for determining the dioptric power are given, distinguished as the *method of precision* and the *rapid method*.

The method of precision depends on the first formula of magnification $G = \frac{f}{q}$.

Two measurements of the magnification are taken with the object placed successively at two different arbitrary distances. The corresponding magnifications are

$$G_1 = \frac{f}{q_1}$$

$$G_2 = \frac{f}{q_2}$$

whence

$$q_2 - q_1 = f\left(\frac{1}{G_2} - \frac{1}{G_1}\right)$$

and

$$F = \frac{G_1 - G_2}{(q_2 - q_1)\, G_1 G_2},$$

q_1 and q_2 denoting the successive distances of the object from the first focal point of the Microscope, though only their difference, i.e. the displacement of the object, need be known.

In the experimental determination the apparatus employed comprises a Helmholtz ophthalmometer A B (fig. 111), and a diffraction bank A S as constructed by Duboscq. On the bank directed parallel to the horizontal optic axis of the ophthalmometer are three vertical supports, carrying respectively the dioptric system L L′, a micrometer P, and a screen of ground glass beyond which is the source of light S. To apply the above formula a first magnification G_1 made by L L′ of the micrometer P_1 is measured with the ophthalmometer. The micrometer is then placed at P_2, and the second virtual image P_2' measured by the ophthalmometer gives the second magnification G_2. The displacement $P_1 P_2 = q_2 - q_1$ is read off on the bank.

The rapid method for determining the dioptric power, which makes use of the camera lucida to measure the magnification of a micrometer, depends on the other expression for the magnification, viz.

$$G_1 = q_1' F = (l_1' + f - d_0) F.$$

Two processes can be employed.

(1) Keeping d_0 constant and displacing the object, its image is formed at a new distance l_2' from the eye, and a second magnification is given by

$$G_2 = q_2' F = (l_2' + f - d_0) F,$$

whence by subtraction

$$F = \frac{G_2 - G_1}{l_2' - l_1'}.$$

In the experimental determination the image of the micrometer is projected by means of the camera lucida on a plane containing a divided scale, and the ratio of the lengths superposed gives the magnification.

(2) The second process consists in making $d_0 = f$, which reduces the above formula to

$$G = l' F,$$

whence

$$F = \frac{G}{l'},$$

so that only one determination of the magnification is necessary. The apparatus employed consists of a horizontal scale (fig. 112) one metre in length, a Wollaston camera P, and a micrometer M, illuminated by a source of light S situated on the other side of a screen of ground glass E. The scale, clearly graduated in centimetres and half-centimetres from 0 to 50 starting from the middle, is strongly illuminated by two gas-burners placed at each end. The camera lucida is placed at the same height as the scale on the perpendicular to its middle point, and at a distance from that point a little less than 5 metres, so that the eye at N may be accurately at that distance from the scale.

The reflecting face *m n* of the camera is inclined at an angle of 45° to the axis N O, and one of the faces of the right angle only intercepts half the cone of rays falling on the eye from the scale.

The micrometer M has for weak magnification a length of one centimetre divided into half-millimetres; the four central divisions are subdivided into 10ths of a millimetre; it is engraved on horn. For strong magnifications the micrometer engraved on glass has a length of 1 millimetre divided into 50ths or into 100ths of a millimetre.

In order to see, before making a determination, that the camera itself gives rise to no magnification, at A′ B′ is placed a second scale 1 metre in length, of which the middle point M′ is at the same distance from the camera as the middle point O of the other scale. When M′ F′ is exactly equal and perpendicular to N O, the eye placed at N sees whether the virtual image of the scale seen by reflection in the camera is exactly superposed over the first scale seen directly.

A camera lucida in which only one reflection occurs, is more suitable than one in which two reflections take place, such as that of Oberhausser and Nachet, since in the former the exact point N occupied by the summit of the cone of reflected rays is known, whereas in the latter a graphical construction would be necessary to determine it. The author draws attention to the error which can follow from neglect of this point and demonstrates how with cameras like those of Nachet and Oberhausser two equal figures drawn in the same plane can never be exactly superposed for an eye which receives them both at the outlet of the camera.

In making a determination, the dioptric apparatus to be examined is placed in front of the camera with its optic axis F′ M′ at right angles to the line of vision N O, and passing through the middle point M of the micrometer. A preliminary observation by the aid of the sun's rays gives the position F′ of the second principal focus. The distance of the diopter from the camera is then regulated so that the focus F shall, after total reflection and deviation through 90°, coincide with the nodal point N of the eye. For systems of very short focus, the eye is armed with a spectacle-glass, as recommended by M. Monoyer.

The number of divisions are then read off on the scale which are exactly covered by a given number of divisions of the micrometer. The ratio of these two gives the magnification at 5 metres. In taking the fifth we have in dioptrics the power of the system.

The preceding method is not applicable to the eye-piece on account of the image being virtual. The difficulty is obviated in the following way. Observation is taken of the magnification of the Microscope with the eye-piece in place, which gives, say, dioptric power Φ_1. A second observation is then taken with the eye-piece completely drawn out, which gives a second dioptric power Φ_2. The extent of the drawing out of the eye-piece is measured. The formula for a system of two lenses of dioptric power F_1 and F_2, and at distances d_1 and d_2 apart, gives

$$\Phi_1 = \delta_1 F_1 F_2 = d_1 F_1 F_2 - (F_1 + F_2)$$

$$\Phi_2 = \delta_2 F_1 F_2 = d_2 F_1 F_2 - (F_1 + F_2)$$

whence by subtraction

$$\Phi_2 - \Phi_1 = (\delta_2 - \delta_1) F_1 F_2 = (d_2 - d_1) F_1 F_2$$

and

$$F_2 = \frac{\Phi_2 - \Phi_1}{(\delta_2 - \delta_1) F_1} = \frac{\Phi_2 - \Phi_1}{(d_2 - d_1) F_1}.$$

For any system of lenses on the same axis can be substituted theoretically one single lens defined in position on the same axis by four points, viz. the two focal points and the two principal points. If one of these pairs of points has been determined, a knowledge of the dioptric power gives the other pair.

Two methods are given for the experimental determination of the focal points of a centered dioptric system.

(1) The first process depends on the formula of magnification

$$G = \frac{f}{q}.$$

If p denote the distance of the object from the nearest face of the diopter, p_f the distance of the first focal point from the first face of the diopter, we have

$$q = p - p_f.$$

Then

$$G = \frac{f}{p - p_f},$$

and

$$p_f = p - \frac{f}{G}.$$

Thus, in order to know p_f, it is necessary, during the determination of the magnification, to measure the distance p of the object from the first face of the diopter.

The determination of the second focal point is made in the same manner by reversing the system.

(2) The second method depends on the formula,

$$G = q' F$$

in which $q' = p' - p'_f$,

p' being the distance of the image from the nearest face.

The practical operation consists in the employment of a sufficiently powerful Microscope. The image and refracting surface are brought successively into focus for that Microscope; the displacement, measured by a micrometer-screw, gives the absolute position p' of the image, and thus the second focal point is obtained. The first is found in the same manner by reversing the apparatus.

The position of the focal points being known, that of the principal points is obtained by measuring off the focal length from these points. Finally, the principal space (distance between the principal points) is obtained by measuring the thickness of the system i. e. the distance between the summits of the extreme refracting surfaces. These processes for determining the optical constants have the advantage over those of M. Cornu, who uses the formula of conjugate foci, in that the apparatus under examination can be kept in a constant position.

When great precision is not required, the following simple method may be used:—An object strongly illuminated at the side of the observer throws its rays on a small plane mirror at a distance of about 5 metres. The beam reflected nearly normally traverses the Microscope under experiment, and gives a very small image of the object, as if the latter were disposed at a distance of 10 metres. The image is situated so near to the principal focus that the difference is negligible.

Finally, the focal points can be determined correct to some tenths of a millimetre, by the aid of the sun's rays without the use of a Microscope, in the following way:—The diopter under examination is fixed with wax to the slide of a slide-rule furnished with a vernier reading to tenths of a millimetre, and the optic axis is brought parallel to the rule. A piece of black paper is gummed on the rule at the zero of the graduation, and the surface of the diopter is brought in contact with it; a first reading is taken, and then, with optic axis turned towards the sun, the diopter is separated from the paper until the observer, with the aid of a lens, sees the refracted cone reduced to a brilliant point. A second reading is taken, and the difference gives the distance of the focus from the first refracting face.

Microscopes are usually provided with a set of eye-pieces and objectives, which can be associated in different ways. To calculate in advance the dioptric power of any associated system, we have the formula for a binary system of diopters F_1, F_2

$$\Phi = d\, F_1\, F_2 - (F_1 + F_2),$$

where d is the distance between the second principal point of the first diopter and the first principal point of the second. If $e_1\, e_2$ and E denote the thickness of objective, eye-piece, and whole Microscope respectively, η_1' the distance of the second principal point of the objective to its last face, and η_2 the distance of the first principal point of the eye-piece to its first face

$$d = E - (e_1 + e_2) + \eta_1' + \eta_2.$$

Just as the dioptric power of the eye-piece was obtained from those of the objective and of the Microscope complete, so by an analogous method can its cardinal points be obtained.

Thus supposing known

E_1, e_1, e_2.
η_1 η_1' the distances of the principal points of the objective to the corresponding refracting surfaces.
Φ the dioptric power of the Microscope.
F_1 ,, ,, objective.
F_2 ,, ,, eye-piece.
p'_ϕ the distance of the second focal point of the Microscope to the last refracting surface.

We have, to determine η_2, $d = E - (e_1 + e_2) + \eta_1' + \eta_2$,

but

$$d = \frac{\Phi + F_1 + F_2}{F_1\, F_2} = \frac{\Phi}{F_1\, F_2} + f_1 + f_2.$$

Therefore η_2 is known, and by adding algebraically the focal length f_2 the distance of the first focal point from the first face is obtained:

$$p_{f_2} = -(\eta_2 - f_2).$$

To determine the second principal point, denoting by p'_ϕ and q'_ϕ the distances of the second focal point of the Microscope from the last refracting surface and from the second focal point of the eye-piece respectively, and by p'_{f_2} the distance of the latter point from the nearest refracting surface, we have

$$p'\phi - q'\phi = p'_{f_2}.$$

But the formula of conjugate foci gives

$$q'\phi = \frac{f_2^2}{\delta} = \frac{f_2^2}{d - f_1 - f}.$$

Thus p'_{f_2} is known since $p'\phi$ is given by experiment, and so also η'_2 since

$$\eta'_2 = f_2 - p'_{f_2}.$$

In the following table are given the results of applying the preceding experimental methods and calculations to a Vérick Microscope with objective No. 2 and eye-piece No. 1.

Experimental Data.

$E = 176^{mm}$	$F_1 = 80^D$	$p'f_1 = -2^{mm}\cdot 37$
$e_1 = 19^{mm}\cdot 5$	$\Phi_1 = 250^D$	$p\phi = 2^{mm}\cdot 78$
$e_2 = 46^{mm}\cdot 9$	$\Phi_2 = 365^D$	$p'\phi = 15^{mm}\cdot 15$
$d_2 - d_1 = 62^{mm}\cdot 5$		

where Φ_1, Φ_2 denote the dioptric power of the whole Microscope with eye-piece in place and drawn out through $62^{mm}\cdot 5$ respectively, $p\phi$ the distance of the first focal point of the whole Microscope from the first face, and $p'f_1$ the distance of the second focal point of the objective from its last face.

Calculated Results.

$f_1 = 12^{mm}\cdot 5$	$q\phi = 1^{mm}\cdot 15$	$pf_2 = 23^{mm}\cdot 85$
$\phi_1 = 4^{mm}\cdot 0$	$pf_1 = 1^{mm}\cdot 63$	$q'\phi = 13^{mm}\cdot 918$
$F_2 = 23^D$	$\eta = 10^{mm}\cdot 87$	$p'f_2 = 1^{mm}\cdot 232$
$f_2 = 43^{mm}\cdot 478$	$\eta_1' = 14^{mm}\cdot 87$	$\eta'_2 = -42^{mm}\cdot 246$
$d = 191^{mm}\cdot 8$	$\eta_2 = -67^{mm}\cdot 33$	

where $q\phi$ denotes the distance of the first focal point of the whole Microscope to the first focal point of the objective, and pf_1 the distance of the first focal point of the objective to its first face.

The author concludes by pointing out the advantages which would result if constructors of Microscopes would take care to provide the micrometer-screws with a graduation, and would furnish with every instrument the optical constants which alone determine its scientific value.

The author arranges his conclusions under the following twelve heads:—

I. The magnification of an optical instrument does not give the measure of its useful effect.

II. The amplifying power is equal to the product of the magnification by the ratio of the distances of the eye to the object and to its image.

III. Two kinds of amplifying power may be distinguished: the absolute and the relative. For the Microscope the latter is the more important.

IV. The relative amplifying power is equal to the dioptric power of a binary system formed by the association of the instrument with a diopter equivalent to the state of accommodation of the eye.

V. Most authors have treated the influence of an instrument on the visibility of objects by the consideration of magnification; some by the relative amplifying power; M. Panum alone has given an expression equivalent to that of the absolute power. The formula of M. Monoyer has the advantage of being more simple, of being applicable to all optical instruments, and of taking account of all conditions of distance, of the instrument, of the object, and of the accommodation.

VI. The relative amplifying power becomes equal to the dioptric power only under two circumstances; when the distance of accommodation is infinite, whatever the distance of the instrument from the eye, or when the second focal point coincides with the first nodal point of the eye, whatever the distance of accommodation.

VII. The dioptric power can then serve to measure the power of the instrument.

VIII. The dioptric power of an instrument situated at an invariable distance from the eye is obtained by dividing by the displacement given to the object the difference of the two magnifications which result from it.

IX. The dioptric power of a system of which the second focus coincides with the first nodal point of the eye is equal to the quotient of the magnification by the distance of accommodation. Thence follows a very simple method for experimentally determining the dioptric power.

X. The determination of the cardinal points of a centered dioptric system, hitherto obtained by the application of the formula of conjugate foci, is advantageously obtained by the aid of the formula of magnification.

XI. This determination can be effected by the aid of simple apparatus without making very important errors. It would be facilitated if instrument-makers would furnish the micrometer-screw with a graduation.

XII. Every Microscope offered by a maker ought to be accompanied by the optical constants most accurately ascertained, which alone determine the value of the instrument.

Royston-Pigott, G. W.—**Microscopical Imagery.**
[Brilliant miniatures and minute molecules—*Colias Cœsonia.*]
Journ. of Microscopy, II. (1889) pp. 205-9 (1 pl.).

(6) Miscellaneous.

The late Chas. Fasoldt.*—The following obituary notice is from the pen of Prof. W. A. Rogers.

"Microscopists will hear of the death of Mr. Fasoldt with unfeigned regret. The work which he has done in fine rulings and in micrometry entitles him to a better recognition than he has received. While there may be a difference of opinion in regard to his skill in the production of test-plates, as compared with Nobert, it must, I think, be admitted that he has made some plates which are quite as good as the best of Nobert's. When it is remembered that he must have been more than fifty years of age before he took up the problem of micrometric rulings, and that he had had no previous knowledge of the subject, his success has certainly been most remarkable.

Two circumstances have acted as a hindrance to the recognition to

* The Microscope, ix. (1889) pp. 174-5.

which he is really entitled. Both of these circumstances have affected his reputation abroad somewhat unfavourably.

The first is the very large claims in regard to his work put forth for Mr. Fasoldt by some of his friends, and to a certain extent, it must be admitted, by Mr. Fasoldt himself. The second is a rugged and somewhat unusual style in his public communications. The latter must be charged wholly to the fact of his inability to convert into felicitous English an essentially German style of speech.

Mr. Fasoldt was a mechanician of rare skill, and he had that element of character which is almost always found associated with real genius—supreme confidence in his own work. This striking trait of his character was of real advantage to him, since it led him to answer criticism by doing better work in new ways. The improvement in his micrometers is especially noticeable. At one time he claimed that his micrometers had no measurable errors. This was simply an expression of faith in his own work at that time. With more experience he found that he had been too sanguine, and so he set for himself the problem of finding the best way to overcome these errors. It will be admitted by all who have used his micrometers, especially those made within the last five years, that his success in this direction has been remarkable. The fact that Mr. Fasoldt, at one time, thought he had reached a degree of perfection greater than is in reality possible, ought not to be remembered against him. He is not the only person who has had, at different times, too great a degree of confidence in his own work, as the writer can testify from personal experience.

Mr. Fasoldt maintained great secrecy in regard to his methods of ruling. The writer believes that the secret of his success consisted wholly in his skill in the preparation of his ruling diamonds. There is some evidence, derived from measurements of his rulings, that he did not use a screw. According to my own experience, there is no difficulty whatever in making the mechanical subdivisions of the ruled spaces far beyond the ability of the ruling diamond to cut a clean line, which has a width less than the interlinear space. But whatever method Mr. Fasoldt may have employed, the results which he obtained must always command the admiration of microscopists, and the service which he has rendered in micrometry deserves grateful recognition."

Scottish Microscopical Society.—We are glad to note that a Microscopical Society has been founded at Edinburgh under this title with every prospect of a successful career. The following gentlemen are the office-bearers for the current year:—

President—Prof. Sir William Turner, M.B., F.R.S., LL.D., Edinburgh.

Vice-Presidents—Prof. D. J. Hamilton, M.B., F.R.S.E., Aberdeen. Adolf Schulze, F.R.S.E., F.R.M.S., Glasgow.

Secretaries—Alexander Edington, M.B., C.M., Edinburgh. George Brook, F.R.S.E., Edinburgh.

Treasurer—John M'Fadyean, M.B., B.Sc., F.R.S.E., Leith.

Curator—German S. Woodhead, M.D., F.R.C.P.E., F.R.S.E., Edinburgh.

Council—Prof. T. Annandale, F.R.C.S.E., Edinburgh; Prof. I. B. Balfour, M.D., F.R.S., Edinburgh; Prof. W. S. Greenfield, M.D., F.R.C.P., Edinburgh; Prof. J. B. Haycraft, M.D., D.Sc., Edinburgh; James Hunter, F.R.S.E., F.R.A.S., Edinburgh; Robert Kidston, F.R.S.E., Stirling; Prof. W. C. M'Intosh, M.D., F.R.S., St. Andrews; Robert Peel Ritchie, M.D., P.R.C.P.E., Edinburgh; Prof. William Rutherford, M.D., F.R.S., Edinburgh.

The following list of papers at the second Ordinary Meeting on 15th November shows the nature of the work the Society propose to undertake:—

1. On the histology of the *Zoantharia*, with demonstration, by George Brook. 2. Demonstration of the histology of the Whale's Stomach, by G. Sims Woodhead, M.D., and R. W. Gray. 3. On the use of Blood-serum as a medium for injection-masses, with microscopic demonstration, by J. Carrington Purves, M.B., C.M., B.Sc. 4. A new Inoculating Syringe for Bacteriological purposes, with exhibition, by Alexander Edington, M.B., C.M.

American Society of Microscopists—Buffalo Meeting.
Amer. Mon. Micr. Journ., X. (1889) pp. 156, 223–35, 237–8.
St. Louis Med. and Surg. Journ., LVI. (1889) pp. 288 and 367.
The Microscope, IX. (1889) pp. 214, 244–5, 328–30.

HOVENDEN, F.—**Presidential Address to the South London Microscopical and Natural History Club.**
[A theory of the continuity of life.]
18th Ann. Rep. South London Micr. and Nat. Hist. Club, 1889, pp. 20–7.

LEWIS, W. J.—**Forensic Microscopy, or the Microscope in its Legal Relations.**
[Annual Address to American Society of Microscopists, Buffalo, 1889.]
Amer. Mon. Micr. Journ., X. (1889) pp. 197–207.

LOWNE, B. T.—**Presidential Address to the Quekett Microscopical Club.**
[On the Anatomy of Insects.] *Journ. Quek. Micr. Club*, III. (1889) pp. 373–86.

PELLETAN, J.—**La Micrographie à l'Exposition universelle de 1889.** (Microscopy at the Universal Exhibition of 1889.)
Journ. de Micrographie, XIII. (1889) pp. 481–93. (*Concl.*)

SCHOTT, O.—**Ueber Glasschmelzerei für optische und andere wissenschaftliche Zwecke.** (On glass-melting for optical and other scientific purposes.)
Central-Ztg. f. Optik u. Mechanik, X. (1889) pp. 243–5. (*Concl.*)

ZUNE, A.—**Traité de Microscopie médicale et pharmaceutique.** (Treatise on medical and pharmaceutical microscopy.)
[I. Description, choice, employment, and preservation of the Microscope and accessory apparatus, &c.]
136 pp. and 41 figs. 8vo, Bruxelles and Paris, 1889.

β. Technique.*

(2) Preparing Objects.

Demonstrating Mitosis in Mammalia.†—Dr. B. Solger recommends the amnion of the rat for demonstrating the mitosis of Mammalia to a class. The freshly cut-out membranes are placed in a saturated aqueous solution of picric acid for twenty-four hours. It is then washed in distilled water previous to immersion in 70 per cent. spirit, the strength of which is to be gradually increased. The preparations are easily stained in five minutes in Ehrlich's hæmatoxylin, diluted one-half with distilled water.

Instead of fixing with picric acid and staining with hæmatoxylin, excellent results are obtainable by means of Flemming's mixture and safranin.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, &c.; (6) Miscellaneous.

† Arch. f. Mikr. Anat., xxxiii. (1889) pp. 517–8.

Mounting Fish-scales.*—Mr. F. Dubois gives the following directions for preparing and mounting fish-scales. Place the scales in a small wide-necked bottle of caustic potash for forty-eight hours, then boil for a few minutes in plain water and afterwards wash in hot water. Partially dry the scales between blotters and place in alcohol for a quarter of an hour to remove all moisture. The scales are then transferred to clove oil for clearing. Now breathe on a clean cover-glass and apply side breathed-on to a glass slip to which it will adhere. Place a small drop of benzol balsam on the cover, put the scale on this, cover it with another drop of balsam, and set aside for twenty-four hours. By the following day the balsam will have become thick from evaporation of the benzol. Now place a drop of fresh balsam on the slide, invert the cover-glass over it, and the mount is ready for ringing as soon as the balsam is dry. Dry mounts should be made on cells, the scales having previously undergone the same treatment.

Preserving Marine Animals.†—M. M. Bedot preserves Siphonophora, &c., in the following manner:—A 15–20 per cent. solution of sulphate of copper is made in distilled water. In this the colony to be fixed is immersed. At the same time as the Siphonophora are plunged in the copper solution sea-water is also poured in along with them, and in such bulk that the copper solution is ten times as great. When the animals are fixed (this happens in a few minutes) a few drops of nitric acid are added to the solution and the mixture is gently stirred up with a glass rod in order to prevent the formation of any precipitate. The Siphonophora are left in the solution for four or five hours, and may then be hardened. Hardening is best done with Flemming's mixture:—1 per cent. chromic acid, 15 parts; 2 per cent. osmic acid, 4 parts; glacial acetic acid, 1 part. In order to avoid touching the animal or removing it from the vessel, the fluids should be changed by decanting. The Flemming's mixture should be allowed to act for twenty-four hours and should be twice the volume of the copper solution.

The next operation, that of transferring the animal to alcohol, should be done very gradually. A few drops of 25 per cent. spirit are first mixed with the fluid by means of a pipette. Gradually the quantity and strength of the spirit are to be increased, until in fifteen days 70 per cent. spirit may be used. After this 90 per cent. spirit may be employed.

Examination of Protozoa.‡—The technique to be observed in the examination of the Protozoa, says Dr. Fabre-Domergue, is divisible into three heads, the examination during life, fixation, staining, and mounting.

In examining the animals while alive, should they be sufficiently large as to be visible with the naked eye, then no cover-glass is necessary, and by gradually diminishing the quantity of water, they are at last rendered sufficiently motionless to be examined with facility. If the animals be found too lively they should be left for some hours in the warm chamber until they have settled down, and this they do usually at a little distance from the edge either of the drop of water or of the cover-glass. Certain colouring matters are very useful, especially

* The Microscope, ix. (1889) pp. 184–5, from The Garner, May 1889.
† Arch. Sci. Phys. et Nat., xxi. (1889) p. 556.
‡ Annales de Micrographie, ii. (1889) pp. 545–551.

Bismarck-brown and anilin-violet. The solutions must be perfectly neutral. The Bismarck-brown stains the organisms without affecting them, while the anilin-violet stains and slowly kills them at the same time. In diphenylamine-blue in concentrated solution the animals swim about unstained and uninjured, hence they show up well against a dark-blue ground.

For fixation, the author advises osmic acid or a mixture of equal parts of 1 per cent. osmic acid and 20 per cent. acetic acid. The animal to be fixed should be placed between slide and cover-glass and observed through the Microscope. When rendered sufficiently motionless by pressure on the cover-glass this latter should be prevented from moving by drops of molten paraffin. The fixative may then be run under the cover-glass in the usual way.

For staining the author recommends picrocarmine, Beale's carmine, alum-carmine or methyl-green. If stained with methyl-green the specimens may be mounted in dilute glycerin or Bram's fluid (water 100, glycerin 10, glucose 40, camphorated spirit 10). The index of refraction of the latter is higher than that of the glycerin, and is proportionately more useful.

The specimens may be mounted in balsam; if so, care must be taken to increase the strength of the dehydrating spirits very gradually; then creosote, and finally xylol-balsam.

Investigation of Infusoria.*—Dr. W. Schewiakoff gives an account of his method of studying Infusoria. He always began his observations with living specimens, which were isolated in a drop of water and fixed to one spot. The necessary pressure was regulated by the removal or addition of water. The best water in which to place the organisms is that in which they were found, and which had been filtered. Observations can best be made on starving specimens. As soon as the animals were completely free of food, artificial feeding was commenced; this of course varies with the habit of the infusorian; those that live on unicellular plants may well be provided with drops of animal fat, which can be easily enough obtained by squeezing a small crustacean. Those that live on Bacteria were provided with indigo or carmine which showed up the characters of the digestive system. When the animals had had enough food they were again placed in clean water and observed further; by this means the position of the anus may, among other things, be made out.

By pressing on the cover-glass with a dissecting-needle the animal is forced to break itself up. As this happens the trichocysts may be observed, the mouth and pharynx be more conveniently examined, and the macro- and micro-nuclei isolated.

To kill specimens the best reagent is the vapour of 1 per cent. osmic acid; larger forms, such as *Dileptus*, must be put in fine tubes with as little water as possible and be placed for some seconds in 1 per cent. osmic acid, when death will be found to follow very suddenly. Preparations thus made are well adapted for the study of the striæ of the body and the protoplasmic structures. When cilia, setæ, or membranellæ are to be studied a 5–10 per cent. solution of soda is recommended. The organisms should be put in glycerin when we desire to study them from different sides. A solution of 1 per cent. acetic acid,

* Bibliotheca Zool., v. (1889) pp. 5–7.

to which a trace of iodine-green has been added, is a good staining reagent.

Mounting Infusoria.*—Prof. C. W. Hargitt places some water containing the animals (paramæcia, vorticella, hydroids) on a watch-glass, and removes as much as possible with a pipette, and completes the reduction by means of a thread siphon. The animals are next killed with a saturated solution of corrosive sublimate, Lang's fluid, which is essentially the same as the foregoing plus a small quantity of acetic acid, osmic acid, or picric acid. After killing, it is only necessary to harden the protoplasm by the ordinary method of alcohol of increasing strength, then to stain them, and afterwards mount in balsam.

Transference from one medium to another is best effected by means of the thread siphon. By this method the author has secured amœbæ naturally expanded, and exhibiting almost every phase of their life-history.

The final mounting may be done with equal success in glycerin or glycerin-jelly.

Medium for mounting Starches and Pollens.†—Mr. A. P. Brown advocates the use of the following medium for starches, pollens, and vegetable tissues:—Selected gum arabic, 2 oz.; glycerin and distilled water, each $1\frac{1}{2}$ oz.; thymol, 1 gr. Put in a wide-mouthed well-corked bottle, and place in a warm situation. Stir occasionally until perfectly dissolved. Then strain through linen and set aside for about a week to get rid of air-bubbles, or filter through a "hot filter."

To mount starches or pollens a clean slide is breathed on and then dusted over with the starch or pollen, excess of which is to be removed by tapping the slide gently against the table. A drop of the mounting medium is then placed on the slide and the cover-glass imposed. If any air-bubbles are in the medium they must be picked out with the needle. The cover-glass may be ringed round with cement directly.

Preparing Diatoms.—Mr. C. Haughton Gill writes:—When cleaned and dry diatoms are soaked in a concentrated solution of ferric chloride (perchloride of iron) for some time all hollow spaces contained in the frustules become charged with the iron salt. If they be now transferred to an acid solution of potassium ferrocyanide, Prussian blue will be formed both outside and inside all hollows and cavities. On washing and levigating with water the outside unconfined portion of the precipitate can be washed away in great part, while those portions which are more or less surrounded by walls of silica remain in place, and serve to clearly mark the position and limits of the spaces containing them.

Evaporating a solution of sodium platinum chloride on cleansed diatoms, and igniting the whole with addition of some crystals of oxalic acid, serves to charge the minute cavities, to be described later, with a deposit of spongy platinum.

Pinnulariæ under either of these treatments show their coarse ribbing to consist of ribbon-shaped tubes contained in the walls of the frustule. *Pleurosigma*, *Stauroneis*, *Cocconema*, &c., show their "dots" to be spaces which can be filled by foreign bodies. *Coscinodisci* have the openings into their lacunæ so large that the precipitates for the most

* Amer. Mon. Micr. Journ., x. (1889) pp. 183–4.
† Amer. Journ. of Pharmacy, April 1889.

part get washed out in the course of mounting, but the cell-walls take so much of colour that their shape and parts can be clearly distinguished.

New Application of Photography to Botany.*—M. F. Fayod proposes a new application of photography for the purpose of obtaining accurate representations of leaves, &c., in order to study the arrangement of the vascular bundles. The method consists in employing the leaf itself as a negative. It is placed on a perfectly clean plate in an ordinary photographic frame, and covered by a sensitized leaf of albuminized paper, such as is usually employed for positive prints. The sensitized paper is pressed close against the leaf, and exposed to the sun in the ordinary way, generally for from 5–20 minutes. The veins being usually more translucent than the mesophyll, the portions of the sensitized paper situated immediately below them become black more rapidly than those below the mesophyll, the green colour entirely absorbing the rays of light; the leaf is reproduced in white on the black groundwork of the paper; every vein being represented by a black line of intensity in proportion to its strength.

Production and Preservation of Saccharine Crystals.†—Mr. Wright Astley states that saccharine may be crystallized by two methods and two differently shaped crystals produced. In the one they are nearly always cube-shaped, in the other nearly always rhomboidal. The first method is performed on an ordinary slide. Take about 6 grams of the pure powder and mix in a 2 oz. bottle three-fourths filled with water. Then pour two or three drops of the mixture on a slide; surmount this with a cover-glass, which clip lightly, and hold over a spirit-lamp until it just boils. It is better to have too much than too little fluid on the slide. Upon cooling crystals will have formed. A similar result is also obtained by putting 6 grains of the pure powder in a 2-oz. bottle and pouring boiling water over this and keeping up the temperature for 4 or 5 minutes. On cooling crystals will have formed.

After a good mount has been secured by crystallizing on the slide, brush off the loose powder round the edge of the cover-glass, and this, with care, will adhere while a ring of brown cement is run round; then finish in the usual way.

Crystals formed in the manner above mentioned may be kept in the mother liquid in a cell. Or make a cell and place in it a drop from the bottle containing the crystals; leave it until the water has evaporated from the cell (24 hours); then finish in the usual way.

LATHAM, V. A.—Practical Notes on Histology.
[Special methods for examination of the eye.]
Journ. of Microscopy, II. (1889) p. 217.

(3) Cutting, including Imbedding and Microtomes.

Imbedding in Glycerin Soap.‡—This method, says Prof. A. Poli, has two great advantages, the soap is very soluble in water and is very transparent. Hence for delicate botanical objects it is invaluable.

* Malpighia, iii. (1889) pp. 120–8 (1 pl.).
† Trans. Manchester Micr. Soc., 1888, pp. 15–7.
‡ Journ. de Micr., xiii. (1889) pp. 337–40, from 'Malpighia.'

The procedure for imbedding is as follows. A mixture of equal volumes of glycerin and 96 per cent. spirit are heated in a water-bath from 60°–70° C. Into this are dropped as many small pieces of glycerin soap as will dissolve. The vessel best suited for the foregoing is a flask, the neck of which may be plugged with cotton-wool in order to prevent the spirit from evaporating too rapidly. The liquid thus obtained is yellow and transparent, but with a slight opalescence. It is then poured into a capsule or paper box. While it is still warm the object to be cut, and which has been removed from strong spirit, is fixed in the desired position by means of needles until the soap has solidified. Large pieces must be soaked for some time in a cold saturated solution of soap before they are removed to the hot fluid.

The imbedding mixture, which should be kept in a stoppered bottle, melts easily at about 40° C.

Very small objects may be readily imbedded by placing them in a drop of the warm solution on a cork, and then covering them with another drop. These small quantities of soap get quite hard in about a quarter of an hour.

The sections are easily freed from the soap by merely washing them in lukewarm water, while the alkalinity of the soap aids in clearing up the specimen.

In practice it is found advisable to use two solutions, one for firm, the other for delicate objects. The ingredients of the former are:—90 per cent. spirit, 32 ccm.; pure glycerin, 32 ccm.; soap, 64 gr. The second contains only 32 ccm. of soap, and is consequently much softer. The harder mass may be sectioned in a Ranvier microtome.

Dextrin Mucilage for Imbedding.*—For those who use the freezing microtome it will be found useful, in the present high price of gum-arabic, to know that gum dextrin answers just as well as the latter, and costs only about one-fifteenth as much. Mr. T. L. Webb writes upon this point to the 'Provincial Medical Journal' as follows:—"I find that by making an aqueous solution of carbonic acid (about 1 part of the acid to 40 parts of water) and dissolving therein sufficient dextrin to make a thick syrup, a medium is obtained which is superior to the time-honoured gum and sugar in three ways. It freezes so as to give a firm support without becoming too hard; it keeps better than gum, in which several kinds of fungi are apt to grow; and it is much cheaper, costing only about fourpence per pound, while powdered gum acacia costs five shillings. Dextrin dissolves but slowly in cold water, so that a gentle heat is advisable when making the mucilage."

Wilks' Improved Microtome.†—Mr. G. Wilks describes an improved form of microtome designed by himself, the principal feature of which is that the cutting-plate, or head, is removable; it is fitted to the lower part by a socket-joint, and secured either by a bayonet-catch or a screw. The hole in the plate or head is bored taper, and is 1/16 in. less in diameter at the outside than in the well or tube of the microtome, thus effectually counteracting the effect of shrinkage in the imbedding material. The diameter of the well is also much less than in the older form of microtome.

* St. Louis Med. and Surg. Journ., lvii. (1889) pp. 231–2.
† Trans. Manchester Micr. Soc., 1888, pp. 86–7.

Thin Sections of Timber.*—For showing the structure of timber Mr. R. B. Hough employs frames made of cardboard holding three samples of wood, each being about 2 in. wide and 5 in. long, and from 1/80 to 1/200 in. thick. These exhibit the wood in three relations; one slice being transverse across the grain, another running radially from the outside towards the heart, and a third is a tangential section. The first and second show both the sapwood and the heart. They also reveal the grain and the structure of the wood in a most beautiful manner. These various frames are arranged in book form for the purposes of study and examination. They retain all the characteristics of wood and are easily recognized, while the effect of the light shining through them is to show the peculiarities of the grain even more emphatically than would be the case if one were looking at a mass of the wood.

(4) Staining and Injecting.

Iodized Hæmatoxylin.†—Sig. F. Sanfelice having noticed that tissues which had been treated with tincture of iodine stained more uniformly, devised a compound of logwood and iodine. This mixture possesses the advantage of giving the same stain as Boehmer's hæmatoxylin to tissues previously treated with tincture of iodine, and of thoroughly penetrating pieces to be stained *in toto.*

Another advantage is that, owing to its antiseptic qualities, it keeps better than most hæmatoxylin solutions. It is prepared by dissolving 0·70 gr. hæmatoxylin in 20 gr. absolute alcohol, and 0·20 gr. alum in 60 gr. distilled water. The first solution is poured drop by drop into the second. The fluid is then exposed to the light for 3–4 days; 10–15 drops of tincture of iodine are added, the fluid is shaken up and allowed to stand for some days. Tissues stain in this solution in 12–24 hours; they are then transferred to 90 per cent. spirit acidulated with acetic acid, in which they are left for the same time.

Staining the Flagella of Spirilla and Bacilli.‡—Dr. Trenkmann's method for staining flagella is as follows:—

A small drop of fluid containing spirilla is placed on a cover-glass; to this is added a large drop of distilled water, and the two intimately mixed. When dry, the cover-glass is placed at once in a fluid which consists of 1 per cent. tannin and 1/2 per cent. hydrochloric acid. In this fluid the preparation remains 2–12 hours, and then having been washed is stained in dahlia (2 drops of a saturated alcoholic solution to 20 water), fuchsin (2–4 drops of a saturated alcoholic solution to 20 water), gentian-violet (1 drop to 80 water), methyl-violet (1 drop to 80 water), methylen-blue, iodine-green, methyl-green, vesuvin, Victoria-blue. In the staining solution the preparation remains 2–4 hours, it is then washed in water and examined. By all these anilin dyes cilia are stained, most strongly by dahlia, fuchsin, or methyl-violet, but still better by carbolic fuchsin (2 drops to 20 of a 1 per cent. carbolic acid).

Another method of staining is by means of catechu. Excess of powdered catechu is macerated in water for some days and the extract filtered. To 4 parts of this catechu solution are added 1 part of a carbolic acid solution, and in this the cover-glass, prepared as before, is

* Amer. Mon. Micr. Journ., x. (1889) p. 187.
† Journ. de Micrographie, xiii. (1889) pp. 335–7.
‡ Centralbl. f. Bakteriol. u. Parasitenk., vi. (1889) pp. 433–6.

placed for 2–12 hours. The best stains after this were dahlia and fuchsin.

A third method is by using a strong solution for 2–12 hours of extract of logwood. After this mordant fuchsin is the best dye. This process is improved by the addition of acids, as hydrochloric acid, 1 per cent.; gallic acid, 1/2 per cent.; carbolic acid, 1–2 per cent.

By these methods the author has been able to show not only cilia, but tufts of them in many spirilla. The micro-organisms specially alluded to are *Spirillum undula*, *Vibrio vagula*, and small vibrios.

Impregnating Tissues by means of Methylen-blue.*—Prof. A. S. Dogiel says that methylen-blue is an excellent substitute for silver nitrate for the purpose of impregnating tissues such as those made up of connective tissue, and also serous membranes. The method of impregnation is as follows:—A 4 per cent. solution of methylen-blue is made in physiological salt solution. In this is placed the piece of tissue quite freshly cut out for 10–20–30 minutes, according as it is desired to show merely the boundaries between the cells, or to obtain a negative picture of the lymph-spaces and vessels.

In the former case it is sufficient to leave the tissue in the solution for only a few minutes; in the second it is better to remove the superficial epithelium from the serous membranes, and leave the tissue in the solution for fifteen to thirty minutes, in order that it may be thoroughly saturated with the dye. At the expiration of this time the preparation is removed and transferred to a saturated solution of picrate of ammonia, wherein after having been carefully washed, it is allowed to stay for half an hour or longer. It is then washed again in some fresh picrate of ammonia, and examined in dilute glycerin.

If it be desired to preserve the preparation for some time, it is advisable to place it in glycerin saturated with picrate of ammonia. The plate shows that the method gives satisfactory results.

Impregnation in Black of Tissues.†—M. Flot adopts the following methods for impregnating tissues, wherein a coloured chemical precipitate is formed by the reaction of two different bodies on each other, and it is therefore owing to this chemical deposit that the preparations are stained:—

(1) Perchloride of iron and tannin. In this are required a concentrated solution of iron perchloride and a solution of tannin in alcohol, made to a syrupy consistence. In a watch-glass are placed two drops of tannin, and in another three or four drops of perchloride of iron; both are filled up with distilled water. The section previously treated with hyposulphate of soda and washed is placed for a minute in the tannin, and then after being passed through water, transferred to the perchloride, whereby it is stained a deep black. As soon as this occurs, it is removed to water and left there for five minutes. Afterwards it is mounted in the usual manner.

(2) Sulphate of copper, bichromate of potash, and extract of logwood. Ten per cent. solutions of copper sulphate and of bichromate of potash are prepared. Five drops of each solution are placed in a watch-glass, and this is then filled up with distilled water. Another watch-glass is filled with a strong solution of extract of logwood. The section is first placed in the logwood solution for about five minutes, and is then

* Arch. Mikr. Anat., xxxiii. (1889) pp. 440–5 (1 pl.),

† Revue Gén. de Botanique, i. (1889) pp. 290–1.

transferred to the copper and bichromate solution, wherein it becomes stained black. Sections stained in this way are extremely valuable for photomicrography. The sections thus stained may be mounted in acetate of potash, glycerin, or in balsam.

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

Method for fixing Serial Sections to the Slide.*—Dr. Gallemaerts recommends Drash's method for fixing sections to the slide. It is performed as follows:—

(1) Make a saturated solution of gun-cotton in acetone, and then add enough absolute alcohol to the solution to make a very thin fluid.

(2) Cover the slide with a thin layer of the liquid.

(3) Arrange the sections, then moisten the slide with a brush dipped in absolute alcohol in order to dissolve the coat.

(4) Mop up the sections with blotting-paper by pressing several folds down on the slide with the finger.

(5) Warm the slide until the paraffin melts.

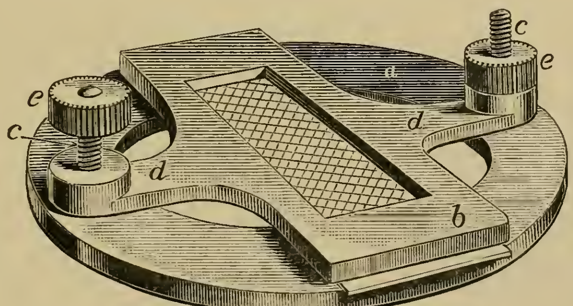
(6) When cool dissolve the paraffin in xylol and mount in balsam.

(7) If the preparations are not stained, after the xylol wash with alcohol; then place them in the stain. When stained, wash in water, and then pass through alcohol and xylol to balsam.

Apparatus for fixing down Series of Sections.†—Dr. I. Dionisio has devised an apparatus for facilitating the manipulation of series of sections. The idea of the apparatus consists in keeping the sections on the slide during the manipulation by means of a fine wire sieve, the meshes of which are proportionate to the size of the preparations.

The apparatus consists of a circular flat ring of metal *a*, upon which

FIG. 113.



lies the oblong frame *b*. From the long sides of *b* two pieces *d d* extend, and end in rounded extremities, through which pass two screws *c c*. These connect the two movable parts, and when the screw-head *e* is turned down, these two parts are firmly fixed together.

Sections fixed up in this way can be treated thoughout the various stages of staining, washing, dehydration, &c., but it is obvious that the instrument cannot be employed with reagents which act upon it (acids, &c.); hence its use would appear to be somewhat limited.

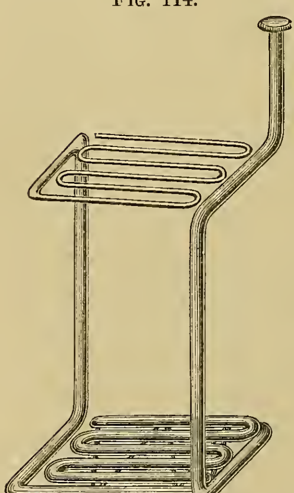
* Bull. Soc. Belg. de Micr., xv. (1889) pp. 56-7.
† MT. Embryol. Instit. Univ. Wien, 1888, pp. 80-4 (1 fig.).

Section-fixing.*—Dr. E. D. Bondurant suggests the following slight variation of the method generally adopted in the use of the clove-oil-collodion process, which he has found to combine the convenience and readiness of application of a liquid fixative with the undoubted advantages offered by the dry-film methods, in that it allows the preliminary arrangement of the section or a number of sections on the slide, and the easy removal of folds and wrinkles, which latter, especially with large thin sections, is often impossible if tissue must lie as it falls,

Place the section (paraffin imbedded) on a perfectly clean slide. Arrange and smooth out folds with a camel's-hair brush dipped in alcohol. Hold an instant over an alcoholic flame until the paraffin partially melts and the section adheres. Paint over the section and slide a thin film of the collodion mixture. Press down with the thumb a bit of tissue-paper coated with same mixture, in the manner recommended by Dr. Reeves, to insure close contact. Planish with mounting forceps, remove the paper, and place the slide on the brass table or water-bath at the melting-point of paraffin, until the clove oil is evaporated, when the section will be found firmly attached, and the slide can be passed through benzol, alcohol, stains, &c., without danger of separation.

Mayer's albumen process can also be used as above, and is satisfactory. Frenzel's gutta-percha and Threlfall's caoutchouc methods are also reliable, but the author thinks the collodion process, used in the manner described, is most available and most certain in its results, and he, for one, feels no need of a better plan.

FIG. 114.



Slide-rest for the Manipulation of Serial Sections.†—The apparatus invented by Dr. J. Dewitz for the manipulation of several slides at a time, is made of glass rod, and can therefore be easily constructed by any person who possesses a blow-pipe and some glass rod or tubing. An inspection of it will show at once the easiness of the manufacture. Glass rod of two different thicknesses is required; the thicker is for the external part of the frame, the thinner for the internal. The illustration shows a frame suitable for five slides, or ten if placed back to back, but of course, as any number of turns can be given to the parallel bars, an apparatus might be constructed for an indefinite number of slides. The slides are slipped in from above, and it will be seen that they can be kept in good position without danger of interfering with one another.

Mounting "selected" Diatoms.‡—Mr. H. Morland "has two methods of preparing slides of selected diatoms," one where the diatoms are gummed down, the other where no cement is used. Choose only the finer and

* The Microscope, ix. (1889) p. 191.
† Arch. f Mikr. Anat., xxxiii. (1889) pp. 416-8 (1 fig.).
‡ Journ. Quekett Micr. Club, iii. (1889) pp. 318-30 (2 figs.).

flatter diatoms. First allow a drop of water containing the material to evaporate on a slide, taking care that the diatoms are not crowded together. By aid of a mounting-bristle, select and lay aside a number of diatoms. Transfer as many as required to the slide, placing them about half an inch to one side of the ruled glass disc in an inked square or circle, so that they can be readily found when wanted. Next breathe on a cover-glass and press it down on the slide, to which it will adhere sufficiently long and firmly for all practical purposes. Place the slide under the Microscope and then arrange the diatoms, as desired, on the cover-glass, and if necessary, owing to dirt or bits of broken diatoms, previously wash in drop of distilled water.

Should the diatoms be concave, the concavity must be placed away from the cover-glass, otherwise when the styrax is applied an air-bubble may be included.

When arranged, breathe gently on the diatoms through the breathing-tube, watching them the while through the Microscope. This causes the diatoms to adhere: too much moisture is easily removed by reversing the process.

The mounting-slip is now placed on the turntable and carefully centered, and then a small "guide-ring," about 1/10 in. in diameter, is traced round the arranged diatoms with a mixture of gum and some colouring matter, such as lampblack. The slip intended for use with the cover can also now be ringed on the under side.

The next thing is to have an iron block heated to 180° F. On this are placed two small pieces of brass about 1 in. apart, on one of which is placed the prepared cover. A drop of styrax is now placed on the centre of the slide; another is then laid on the hot block in order to remove all traces of its benzole solvent. While still hot it is turned over and lowered gently down on the cover-glass. If any air-bubbles are included, let the slide remain on the hot block until they disappear. If balsam be used instead of styrax, it must be applied cold.

If the diatoms be large, heavy, much concave, or beset with spines, they must be fixed down with some cement. The author, who recommends gum, first applies the minutest drop of gum arabic dissolved in water by means of a glass rod to the centre of the cover-glass, after this has been fixed to the ruled disc by means of the breath. This drop is then allowed to dry, and any desired consistence may be imparted to it through the breathing-tube. The diatoms are then arranged in the manner desired, and mounted in balsam.

Carbolic Acid in Mounting.*—Mr. F. T. Chapman considers that carbolic acid is superior to the ordinary media used for mounting insects. The strongest uncoloured acid should be used: small insects can be cleared therein in a few minutes, and immediately mounted in balsam without further treatment.

The solid acid may be liquefied either by the addition of 5–10 drops of water to the ounce, or if it can be used warm, by the aid of heat. The time required for clearing an object varies, the head of the common house-fly taking about a week.

Objects to be mounted in benzole balsam should be first passed through oil of cloves in which they are allowed to remain until all surface agitation has disappeared.

* Amer. Mon. Micr. Journ., x. (1889) pp. 127–8.

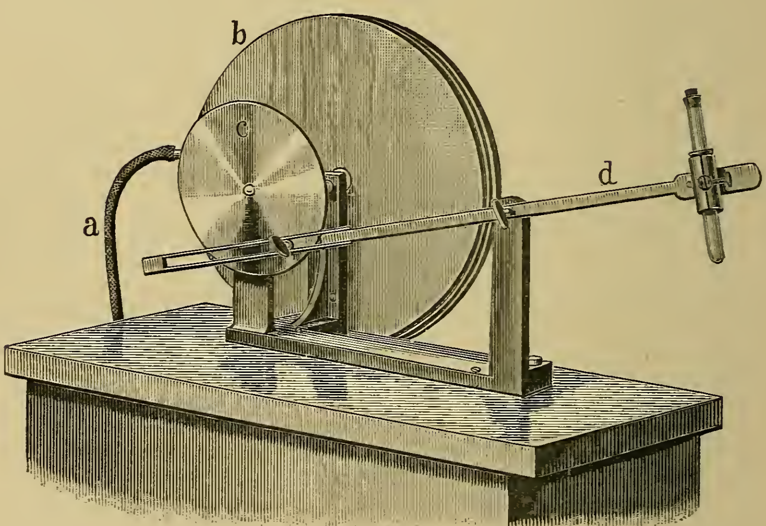
The disadvantage inherent to carbolic acid of becoming embrowned by time and exposure to light is retarded by using 95 per cent. alcohol as the liquefying agent instead of water.

SHERMAN, W. W.—**Notes on Balsam Bottles.**
[Simple and effectual device for preventing the smearing of balsam and other resinous and sticky substances, with the consequent adhesion of the cork to the neck of the bottle. A piece of soft whalebone is bent and placed in the bottle, so that superfluous fluid may be removed on its arch. Also suggests the use of a glass-capped bottle.]
The Microscope, IX. (1889) p. 277.

(6) Miscellaneous.

Apparatus for Isolating Objects.*—Dr. W. Behrens gives an account of an ingenious apparatus intended to save the labour of shaking out or removing certain parts from a specimen. It consists of a circular tin box, fig. 115 *b*, containing a water-wheel to which water is carried

FIG. 115.



through the tube *a*, and removed by a similar tube not shown in the illustration. The water-wheel drives a circular metal disc *c*, in which, in one radius, is a series of holes. Into any of these holes is fixed a screw which connects the forked end of a long lever *d* to the apparatus. At the other end of the long piece *d* is a clamp for holding the test-tube, which is plugged when the apparatus is in motion.

The amplitude of the movement imparted to the test-tube depends of course on the distance of the screw from the end of the lever.

* Behrens, Kossel, and Schiefferdecker, 'Das Mikroskop,' i. (1889) pp. 161–2 (1 fig.).

New Method for the Bacteriological Examination of Air.*—The microbiometer of Dr. E. Forstetter consists essentially of a U-shaped glass tube (fig. 116) E E, at one end of which is a largish bulb M. The latter is connected by a short neck with a test-tube B, the inferior extremity G of which is made bulbous in order to contain a sufficient quantity of gelatin. C is the aperture of entrance, and B that of exit.

Into the U-shaped tube is introduced about 10 ccm. of distilled water E E, and into the bulb G 15 ccm. of 12 per cent. nutrient gelatin. The apertures having been plugged with cotton wool, the apparatus is sterilized in the usual manner. When required for analysis the plug is removed from C and the aspirator fitted in B, and air drawn through at the rate of about 10 litres an hour. The experiment over, the

Fig. 116.

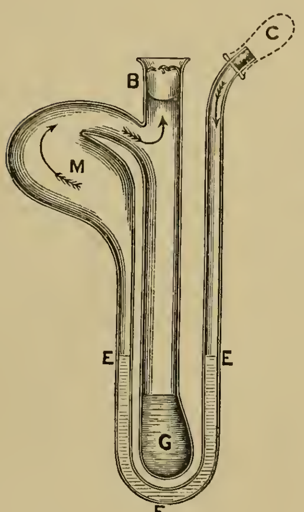
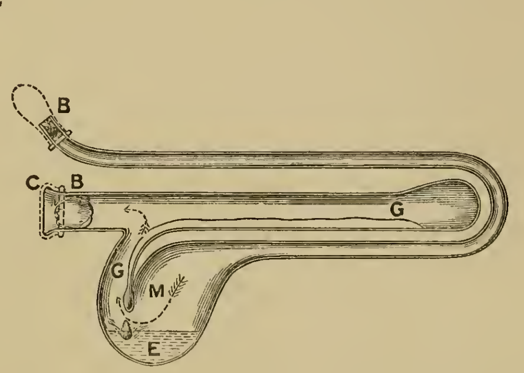


Fig. 117.



orifices are replugged, and then the gelatin melted by the aid of very gentle heat. The instrument is then placed in the horizontal position, fig. 117, so that the water and gelatin mix together in the bulb M. When thoroughly mixed, the fluid is dispersed over plates for the cultivation of this organism. The removal of the gelatin mixture is easily effected through the opening B.

The aspirator employed by the author is a portable one capable of drawing in 20 litres of air an hour. It consists of a clockwork arrangement acting on two rubber bellows, shaped like a Chinese lantern. A needle on a dial-plate indicates the quantity of air which has passed through.

Examining thin Films of Water.†—Mr. F. Hovenden draws attention to the interesting phenomena presented by a thin film of water under the Microscope. The film may be obtained by simply breathing on the

* Annales de Micrographie, ii. (1889) pp. 567–71 (2 figs.).
† 18th Ann. Rep. South London Micr. and Nat. Hist. Club, 1889, pp. 10-1.

blade of a knife, when the steam will condense and the disappearance of the water can be observed with a half-inch power. As the globules evaporate, they appear to leap into the air, the actual point of final disappearance, however, being difficult to detect. Some curious questions as to molecular action are raised by this experiment, as well as by those which he suggested should be made in connection with thin sections of iron.

Kurz's Transparent Microscopical Plates.—Dr. W. Kurz, of Vienna, has edited plates which contain representations true to nature of typical preparations intended to produce the impression of a microscopic image. They are printed in transparent colours, and during observation are turned towards the light. The special advantages claimed for this mode of demonstration over the use of the Microscope are that a whole school can observe at the same time the object described, so that the pupils need not leave their seats and the teacher can draw their attention to every single part of the object represented.

Duncan, A. W.—**The Microscopical Examination of Food for Adulteration.**
Trans. Manchester Micr. Soc., 1888, pp. 49–52.

Freeborn, G. C.—**Histological Technique of the Blood.**
Amer. Mon. Micr. Journ., X. (1889) pp. 217–22 (1 pl.).

Whelpley, H. M.—**Microscopical Laboratory Notes.**
The Microscope, IX. (1889) pp. 139–40.

PROCEEDINGS OF THE SOCIETY.

Meeting of 9th October, 1889, at King's College, Strand, W.C., the President (Dr. C. T. Hudson, F.R.S.) in the Chair.

The Minutes of the meeting of 12th June 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
Braithwaite, R., The British Moss Flora. Pt. xii. pp. 57–184, 7 pls. (8vo, London, 1889)	*The Author.*
Cooke, M. C., Toilers in the Sea. viii. and 373 pp., 4 pls., and 70 figs. (8vo, London, 1889)	*The Society for Promoting Christian Knowledge.*
Deby, J., Bibliotheca Debyana. Catalogue of Books in the Library of J. Deby, M.E., F.R.M.S., vol. i., 151 pp. (8vo, London, 1889)	*The Author.*
Hudson, C. T., and P. H. Gosse. The Rotifera or Wheel-animalcules, Supplement. vi. and 64 pp. and 4 pls. (8vo, London, 1889)	*Messrs. Longman.*
Matthews, C. G., and F. E. Lott. The Microscope in the Brewery and Malt House. xxi. and 198 pp., 22 pls. and 30 figs. (8vo, London and Derby, 1889)	*The Authors.*

The President said, with reference to the 'Supplement,' that the original notion of Mr. Gosse and himself was to have made their book on the Rotifera complete; but whilst it was in progress of publication so much was done, and so many new species were added by Mr. Gosse, that they found it was not possible to include all, and the foreign Rotifera had also to be put on one side. Later on, when he had the foreign species under consideration, he began to be afraid that they would have to be permanently left out; bnt he found that their own list contained so many foreign forms, that it was eventually possible to include the others, and although this part had been done briefly, it had, he believed, been done completely, so that the 'Supplement' included everything which was not contained in the original work.

Mr. Crisp called attention to the confusion in 'The Microscope in the Brewery' in connection with working distance and magnifying power. He also called attention to the publication of Part 12 of Dr. Braithwaite's 'British Moss Flora,' which came fully up in point of excellence to those which had preceded it.

Mr. Crisp said he had to trouble the meeting with a personal matter, and that was to announce that he was obliged to retire from the Secretaryship of the Society, and from the conduct of the Journal. The Council had been aware for some years that his continuance in office was contingent upon certain business arrangements, and though that contingency had happily been long deferred, it had now taken effect, and the whole of his attention was absorbed to an extent that would not allow of his offering himself for re-election. There would, he anticipated be no difficulty in continuing the Journal on its present lines, while he was sure there were many Fellows both able and willing to undertake the duties of microscopical Secretary. It was with the greatest reluctance that he had found it necessary to resign, but, at the same time, he had always felt that twelve years of one *régime* was as much as was good for a society.

Mr. John Meade's communication was read on "Stereoscopic Photo-micrography," in which he claimed to have been the first to produce stereo-photomicrographs. Specimens were sent in illustration.

Mr. J. D. Hardy said he had a photo-micrograph which he had made on the same principle about seven years ago. It was of the eggs of the domestic fly.

Mr. E. M. Nelson said that the plan of taking stereoscopic photo-micrographs in this way had been known for a long time. One way in which they were done, was to cover up alternately each half of the objective, taking a photograph from each, the two being afterwards mounted as a stereoscopic picture.

Mr. Crisp said the subject had been exhaustively dealt with many years ago by Dr. Fritsch in his 'Ueber das stereoskopische Sehen im Mikroskop und die Herstellung stereoskopisher Mikrotypien auf photographischem Wege" (1873), while Dr. Stein's 'Das Licht' contained a good summary of the subject.

The President said he had brought with him for inspection three photomicrographs of one of the new rotifers mentioned in his 'Supplement'—*Gomphogaster areolatus*. They were unfortunately not good specimens, but though very indistinct, they were sufficiently like the drawing shown at a previous meeting to enable the creature to be recognized as the same. It was necessarily very difficult to get a good photograph of an object of this sort.

Mr. E. M. Nelson said he had brought for exhibition a new elementary centering substage which he thought was likely to be useful. It was fitted in the simplest manner by placing two lugs under the main stage, and the movement was given to it with the finger; it was very inexpensive, and was only designed to render the ordinary student's Microscope of a higher degree of efficiency by providing it with an easy method of correctly centering the condenser and diaphragm.

Mr. J. Mayall, jun., thought that in this case Mr. Nelson had really hit upon a novelty of design. The need of a simple and accurate centering substage for inexpensive Microscopes had long been a serious impediment to the skilful use of such Microscopes. Mr. Nelson's new substage would add greatly to the efficiency of students' Microscopes at small cost. He believed that a few hours' practice would enable any one to master the use of the new substage, and he thought Mr. Nelson was very much to be congratulated upon its production.

The President said Mr. Rousselet was showing under his Microscope a specimen of *Limnias cornuella*, a new and very pretty creature which they would find well worth looking at. In this animal the tube, instead of being made with a simple bore, sometimes with a straight axis and sometimes curved, was in the form of a screw, being twisted round upon itself. Mr. Rousselet's drawing showed this very clearly. Mr. Western also had a curious rotifer for exhibition.

Mr. Western said it was a specimen of *Rotifer citrinus* which was found by Mr. Chapman on Wimbledon Common.

The President mentioned that *Pedalion* was to be had in many places in the neighbourhood of London about a month ago, where it had not been previously found, though Mr. Shepherd had found it repeatedly in the lily tank at Eaton Hall, near Chester. It was very curious to note how, when a rotifer made its appearance in one locality it was generally found in a number of other places surrounding, as if the eggs were carried about and distributed by the wind along with the dust. He also wished to draw a picture of what Mr. Rousselet had called his attention to in connection with the small vibratile tags attached to the lateral canals, the use of which had been so difficult to make out in the case of *Asplanchna*. He had not mentioned it in the Supplement to the 'Rotifera,' but he found that in Daday's last memoir, printed in Hungarian, it was shown quite plainly. Having made and explained drawings of the structure on the blackboard, the President said that the conclusion he had come to was that the hairs were intended to protect the openings from the intrusion of any bodies which might tend to obstruct the tubes, and if this was so it would seem to demonstrate that there were openings. He had seen these hairs frequently loaded with matter apparently strained out from the water.

Mr. Ahrens's description was read of his new patent polarizing binocular Microscope for obviating the difficulty of using analysing prisms with the double tube. The inventor uses for an analyser a black glass prism, set above the objective with a horizontal side upwards. Two faces are symmetrically inclined to the optic axis at the polarizing angle. The pencil is thus reflected at the proper angle, and at the same time divided into two parts, which are then reflected up the two tubes either by prisms or by plane reflectors (*ante*, p. 685).

The President said the Fellows must have heard with great regret of the deaths of the Rev. M. J. Berkeley and Dr. G. W. Royston-Pigott, the former an Honorary, and the latter formerly an Ordinary Fellow of the Society. They were both too well known to need any statement from him as to their work.

Mr. Crisp said they had also heard of the death in America of Mr. C. Fasoldt, sen., so well known as a ruler of fine lines.

Prof. Abbe's paper, "Notes on the Effect of Illumination by means of Wide-angled Cones of Light," was read (*supra*, p. 721).

The President thought it would be obvious that a paper like that of Prof. Abbe's could hardly be followed when read to the meeting—although full justice had been done to it in that respect by Mr. Crisp. It could only be fairly dealt with when seen in print in connection with the figures which illustrated it.

Mr. T. F. Smith said that personally he had never objected to the diffraction theory itself; but only to certain conclusions which some persons had drawn from it.

Mr. T. F. Smith read a paper "On the Ultimate Structure of the *Pleurosigma* Valve" (*supra*, p. 812).

Prof. Bell said he was disappointed to find that a specimen which he had brought for exhibition at the meeting was dead. It was a fine specimen of *Virgularia mirabilis*, which had been sent to him by post from the west coast of Scotland by Mr. Gathorne Hardy. He had to attend a committee during the afternoon, and, having the tube in his pocket, the warmth had proved too much for it, and it had broken up and disintegrated. He regretted that he was in consequence unable to show what was certainly a very interesting and beautiful organism, so that for the moment they would have to be content with the knowledge gained by his experience, namely, that it was now possible to get living specimens delivered in London from Scotland in a healthy condition by the parcel post.

The following Instruments, Objects, &c., were exhibited:—

Prof. Bell:—*Virgularia mirabilis.*

Dr. Hudson:—Three Photomicrographs of *Gomphogaster areolatus.*

Mr. J. Meade:—Stereoscopic Photomicrograph of head of Crane Fly.

Mr. Nelson:—Baker's Student's Microscope with new elementary centering Substage.

Mr. Rousselet:—*Limnias cornuella.*

Mr. T. F. Smith:—Valve of *Pleurosigma formosum* in illustration of his paper.

Mr. Western:—*Rotifer citrinus.*

New Fellows:—The following were elected *Ordinary* Fellows:—Surg. P. W. B. Smith, R.N.; and Surg. V. Gunson Thorpe, R.N.

MEETING OF 13TH NOV., 1889, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (DR. C. T. HUDSON, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 9th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Behrens, W., A. Kossel, and P. Schiefferdecker, Das Mikroskop und die Methoden der mikroskopischen Untersuchung. Band i., viii. and 315 pp., 193 figs. (8vo, Braunschweig, 1889)	*Dr. W. Behrens.*
Dowling, C. H., Series of Metric Tables	*Mr. Crisp.*

The Rev. Henry Armstrong Hall said that he had brought for exhibition a preparation which he thought would be found of interest. In January of the present year Dr. Bullock—who was at the meeting that evening—gave him a sample of urine which, when examined under the microscope, was found to contain a particular bacillus. After the ordinary process of preparation, and after staining by the method of Neilson, on the eighth or ninth slide being examined, he found a bacillus which resembled very closely in appearance *Bacillus tuberculosis.* Having afterwards obtained another sample from the same source, he found in the albuminous residue a still larger proportion of the same bacillus; but although it showed the same beaded appearance, and had the same power of retaining the stain in the presence of nitric acid, he could not, of course, say yet that it was *B. tuberculosis*, though it very strongly resembled it in appearance. He believed that it was very rare to find it in this way in the urine, though it was said that in some cases of tubercular disease of the kidney it was to be found. The patient from whom the specimens came was alive, and the case was looked upon as one of great interest by Dr. Bullock, and if it subsequently proved that this bacillus was really identical with *B. tuberculosis*, it would show the importance of its being looked for in similar cases. The preparation shown under the Microscope in the room would be seen to be full of the bacilli, lying mostly in groups.

Dr. Bullock said the case to which Mr. Hall had referred had been under his care for some time, and had presented considerable difficulty in diagnosis. Several opinions had been taken upon it; and the question was whether it was a case of calculus in the kidney, or whether it was one of tuberculosis. This was obviously of great importance to determine, since if it was calculus it would be remediable by operation, whereas if the case was one of tuberculosis nothing could be done. After seeing the bacillus, and considering the specific gravity of the water, he was inclined to think that there was tuberculosis.

Mr. G. C. Karop said it was well known that tuberculosis of the kidney could be detected by the examination of the urine, the presence of bacilli having been observed since about 1882. The morphological characters of bacilli were, however, so very variable, that it was hardly safe to rely simply upon the appearance they presented. He would not, of course, venture to say that those which were obtained in this case were not *Bacillus tuberculosis;* but he should not like it to be thought that this method of examination in suspected cases of this disease was uncommon or usually neglected.

A Fellow asked if there had been any attempt made to cultivate the bacillus?

Mr. Hall said that this had not yet been done, though it was in contemplation. He had shown it to Prof. Crookshank, and though he very properly declined to commit himself to any opinion at present as to what specific form it was, he proposed to follow up the matter by cultivation, and eventually to test it by inoculation.

Dr. Hebb inquired if Dr. Bullock would state the age of the patient, also how long the case had been under treatment; whether there was any tubercular disease of the lungs, or any in the family history?

Dr. Bullock said that the patient was twenty-one years of age, and the symptoms were of about 4½ years' duration. The first complaint was of pain in the right kidney, and then for a long-continued period there was pain in the left kidney. He found there was lithic acid present in the urine, and there had been some symptoms of stone in the bladder, as well as several symptoms of stone in the kidney; but at present there was the very low specific gravity of 1·0004, though some time ago it had been 1·009. There seemed no trace of tubercular disease of the lungs, and there was none in the family history, except possibly in one sister.

Mr. J. D. Hardy exhibited and described a little apparatus which he had devised for the purpose of photographing an object under the Microscope without having to alter the position of the instrument in any way. It was, in some respects, the same as one which he exhibited at the Quekett Club about three years ago; but whereas that one was made of metal, and was found to be too heavy, the one before them was made of wood, and its weight was only about 1 oz., the cost being nothing at all beyond the trouble of making it. He thought that its simplicity and lightness would hardly fail to recommend it, especially as most of the commercial instruments of that sort were evidently designed by those who did not understand the requirements of the case. Having described the *modus operandi*, and stated that with the ordinary Ilford plate the exposure required with a 1/4 in. objective was about four minutes, he handed round some specimens of the photographs taken by the apparatus.

Messrs. Watson and Son exhibited and described a new pattern microscope for students (the Edinburgh Student's Microscope), and a student's petrological Microscope, made upon the same lines. Also a small box for holding slides, which presented some features of novelty, and for which a provisional patent had been obtained by Mr. Moseley, its inventor. The slides were held in flat trays, in the usual way, but they were so arranged that upon opening the front of the box the trays were drawn forward, so as to form a series of layers overlapping sufficiently to expose the labels at the front end of each row, and enabling the position of any particular slide to be seen without the necessity for removing the trays in search of it.

Mr. Crisp said this seemed to be a real novelty in cabinets, and until he saw it he certainly had thought they must have got to the end of anything new in the way of putting objects into cabinets.

The President said the Fellows present should all take a look at the box, as it was a model of ingenuity, and met a want which all must have frequently felt.

Mr. Crisp said they had from time to time commented unfavourably upon the late Mr. C. Fasoldt, in connection with his claim to have seen lines 250,000 to the inch. He had received a copy of an obituary notice of Mr. Fasoldt, written by Prof. Rogers, which dealt with the deceased's work, and accorded him a high measure of praise for what he had done, and, under those circumstances, he thought it would be proper to read it now, and to publish it *in extenso* in the next number of the 'Journal' (*supra*, p. 829).

Mr. Crisp called attention to a statement published by M. Pelletan, on the authority of Dr. Eyrich, of Mannheim, to the effect that Dr. R. Zeiss had produced a 1/12 in. immersion objective with a numerical aperture of 1·60, using monobromide of naphthaline. This was higher than anything which had hitherto been accomplished; but the use of such objectives was likely to be restricted, owing to the price, which was 10,000 fr. or 400*l*.

Mr. T. Powell, in reply to a question as to the possibility of producing such an aperture, said it would be quite possible to make it with such a medium as the immersion fluid named, that was, of course, supposing its refractive index was as high as 1·6.

Mr. Ingpen said that the refractive index of this medium was 1·8.

Mr. Crisp said that it would be remembered that some time ago an extraordinary description was read at one of their meetings from the Proceedings of the American Association for the Advancement of Science, a society having the same object as our British Association, in which it was proposed to convert a Microscope into a microtome by placing the imbedded substance in the lower end of the tube and cutting sections by means of a blade fitted to move upon the stage-plate, the material being moved forward by the action of the fine-adjustment. He had now brought the apparatus described for exhibition, as it might well be thought that the original account was written as a joke, and that it could not be seriously put forward. Having fitted up the contrivance in the manner described, he showed the way in which it was proposed to be used.

Mr. Karop and Mr. J. Mayall, jun., made several suggestions as to possible conversions of a Microscope to domestic and other uses if it was not considered necessary to confine it to its original purpose.

Mr. J. Mayall, jun., described the various Microscopes and accessories which he had examined at the Paris Exhibition, pointing out that whereas at former international exhibitions most of the best makers in England, America, and other countries, were exhibitors, on this last occasion they had been rather conspicuous by their absence. He had seen very little that was new in the matter of design. The French opticians were fairly well represented as to numbers, but the instruments they exhibited were for the most part of the old, not to say antiquated types. Where, perchance, one or another had ventured to add an adjustable substage to his Microscope, this had been done in what English microscopists would regard as a clumsy and ineffective way, by no means up to the standard that would be required in England. When French opticians were questioned why they did not produce Microscopes more suitable for the critical microscopy of the present day, they replied that there was no amateur scientific class in France as in England, and that they were therefore obliged to restrict themselves to what was suitable for medical use; that medical students there used the Microscopes very roughly, and the instruments had consequently to be made strong and heavy, without much regard to delicacy of adjustment. Comparing the French exhibits with those of previous exhibitions, he thought the advance shown was principally in the direction of finer lacquering or nickelizing, or more elaborate upholstery. Here and there ingenuity was shown in packing a portable Microscope in a very small space, or in making a large number of appliances fit into dainty-looking velvet-lined partitions, so that the eye at least was pleased; but the solid merits of construction and design, as evidenced by good mechanism giving the microscopist perfect command of all necessary adjustments, seemed to be almost wholly neglected. Some little attention had been given to photo-micrographic combinations of apparatus; but here again the main essentials of steadiness and facility of adjustment were lost sight of, or were so encumbered with useless fittings that one could only view them as eccentricities of ingenuity. The German opticians were wholly absent, as also were the American. The English were represented by Ross & Co., Dallmeyer, Pillischer, and Watson & Sons. The Grand Prix had been awarded to Ross & Co., presumably for the variety and importance of their exhibits, which included a new pancratic eyepiece for the telescope, doing away with the necessity of altering the focal adjustment, sundry improved photographic lenses and cameras, and Wenham's radial Microscope. Of course the award of the Grand Prix did not commend itself to the less successful competitors, and some dissatisfaction was expressed at the appointment of M. Alfred Nachet as the microscopical expert to advise with the jury. It seemed to him, however, that no more competent man was known in Paris than M. Nachet, and it was a matter of course that the expert should be a Frenchman. He (Mr. Mayall) had endeavoured to set aside all prejudice, and to estimate the quality of the exhibits impartially, and he was bound to say the award of the Grand Prix to Ross & Co. seemed to him equitable, for their apparatus, viewed as a whole, was the most important of the optical exhibits. He could have wished there had been more of commendable novelty in the Wenham radial Microscope, as exhibited in its latest form; still, when compared with the other Microscopes in the exhibition, it had really no worthy rival. He thought it much to be regretted that Messrs. Powell and Lealand did not exhibit; had they done so they would easily have carried the palm for Microscopes. There appeared to have been a great many unnecessary difficulties thrown in the way of the English exhibitors. They were shunted up into the galleries, where their exhibits were practically unseen, and all sorts of vexatious conditions were imposed at the outset that dismayed the bulk of intending exhibitors. In the face of these unfavourable conditions he could well understand the reluctance of Messrs. Powell and Lealand, Beck, and Swift to compete, especially with the experience they had of the difficulties of being properly represented at the Paris Exhibition of 1878.

The President said they must all feel greatly indebted to Mr. Mayall for the trouble he had taken in explaining what he had seen as well as in looking at the exhibits for this purpose.

The President announced that the Conversazione would take place on November 27th.

The following Instruments, Objects, &c., were exhibited:—

Mr. Crisp:—Hart's Microtome Microscope.

Rev. H. A. Hall:—Bacillus from Urine.

Mr. J. D. Hardy:—Photomicrographic Apparatus.

Messrs. Watson and Sons:—(1) Edinburgh Students' Microscopes. (2) Moseley's Slide Cabinet.

New Fellows:—The following were elected *Ordinary* Fellows:—Mr. H. C. B. Chamberlin, and the Rev. P. W. Hart-Smith, M.A.

INDEX.

C.

E.

H.

N.

O.

T.

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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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CONTENTS.

NOTICE TO BINDER.

Cancel Plate X., "New Peritrichous Infusoria" (issued with August Number).

Substitute Plate X., "New Peritrichous Infusoria *from the United States*" (issued with October Number).

THE

ROYAL MICROSCOPICAL SOCIETY.

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

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

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

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

The Admission Fee is 2*l.* 2*s.*, and the Annual Subscription 2*l.* 2*s.*, payable on election, and subsequently in advance on 1st January annually, but future payments may be compounded for at any time for 31*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 permanently residing abroad are exempt from one-fourth of the annual subscription.

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

Ex-officio Fellows (limited to 100) consisting of the Presidents for the time being of any Societies having objects in whole or in part similar to those of the Society, are elected on the recommendation of ten Ordinary Fellows and the approval of the Council.

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

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

The Library, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M., and on Wednesdays from 6 to 9 P.M. also. It is closed for four weeks during August and September.

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